



中华人民共和国石油天然气行业标准

SY/T 5788.3—2008

中文/English

代替 SY/T 5788.3—1999

油气井地质录井规范

Specifications for geological logging of oil and gas wells

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目 次

前言 II

1 范围 1

2 规范性引用文件 1

3 录井环境 1

4 含油级别划分 1

5 岩石定名及描述内容 3

6 录井内容及要求 4

7 资料项目 9

前 言

本标准代替 SY/T 5788.3—1999《油气探井地质录井规程》。

本标准与 SY/T 5788.3—1999 相比，主要差异如下：

- 标准名称修改为《油气井地质录井规范》；
- 修改了 SY/T 5788.3—1999 中第 2 章、第 3 章、第 4 章、第 5 章和第 6 章的部分内容；
- 删除了 SY/T 5788.3—1999 中的附录 A 和附录 B；
- 增加了“特殊钻井作业简况”的内容和第 7 章。

本标准由石油地质勘探专业标准化委员会提出并归口。

本标准起草单位：中国石油化工集团公司江汉石油管理局测录井工程公司、中国石油天然气集团公司辽河石油勘探局录井公司、中国石油化工集团公司中原石油勘探局地质录井处、中国石油化工集团公司华北石油局地质录井公司。

本标准主要起草人：徐流才、叶应贵、胡端义、邹筱春、曾永文、刘志刚、陈英毅。

本标准所代替标准的历次版本发布情况为：

- SY 5090—1985；
- SY 5364—1989；
- SY 5365—1989；
- SY/T 5788.3—1993，SY/T 5788.3—1999；
- SY/T 6157—1995。

本标准以中文和英文两种文字出版。当英文与中文两种版本有歧义时，以中文版本为准。

油气井地质录井规范

1 范围

本标准规定了油气井地质录井的内容、流程、方法及要求。
本标准适用于油气井地质录井。

2 规范性引用文件

下列文件中的条款通过本标准的引用而成为本标准的条款。凡是注日期的引用文件，其随后所有的修改单（不包括勘误的内容）或修订版均不适用于本标准，然而，鼓励根据本标准达成协议的各方研究是否可使用这些文件的最新版本。凡是不注日期的引用文件，其最新版本适用于本标准。

- SY/T 6294 录井分析样品现场采样规范
- SY/T 6611 石油定量荧光录井规范

3 录井环境

- 3.1 钻井液循环系统的高架管应加装缓冲罐，满足录井要求。
- 3.2 保证淡水水源接至洗样处，且水质清洁、供水正常。
- 3.3 振动筛的工作状况应满足岩屑录井需求，且振动筛旁应安装防爆照明灯。
- 3.4 录井仪器房应使用专线供电，电压 $380\text{ V} \pm 38\text{ V}$ 、频率 $50\text{ Hz} \pm 2\text{ Hz}$ ；地质值班房和砂样房所需电源电压 $220\text{ V} \pm 22\text{ V}$ 、频率 $50\text{ Hz} \pm 2\text{ Hz}$ 。

4 含油级别划分

4.1 岩心含油级别划分

4.1.1 孔隙性地层含油岩心含油级别的划分见表 1。

表 1 孔隙性地层含油岩心含油级别划分

含油级别	含油面积占岩石总面积百分比 %	含油饱满程度	颜 色	油 脂 感	味	滴水试验
饱 含 油	>95	含油饱满、均匀，局部见不含油的斑块、条带	棕、棕褐、深棕、深褐、黑褐色，看不见岩石本色	油脂感强，染手	原油味浓	呈圆珠状，不渗入
富 含 油	>70 ~95	含油较饱满、较均匀，含有不含油的斑块、条带	棕、浅棕、黄棕、棕黄色，不含油部分见岩石本色	油脂感较强，染手	原油味较浓	呈圆珠状，不渗入
油 浸	>40~70	含油不饱满，含油呈条带状、斑块状、不均匀分布	浅棕、黄灰、棕灰色，含油部分看不见岩石本色	油脂感弱，可染手	原油味较淡	含油部分滴水呈半珠状，不渗—缓渗
油 斑	5 ~40	含油不饱满、不均匀，多呈斑块状、条带状含油	多呈岩石本色	油脂感很弱，可染手	原油味很淡	含油部分滴水呈半珠状，缓渗

表 1（续）

含油级别	含油面积占岩石总面积百分比 %	含油饱满程度	颜 色	油 脂 感	味	滴水试验
油迹	>0~<5	含油极不均匀，含油部分呈星点状或线状分布	为岩石本色	无油脂感，不染手	能够闻到原油味	滴水一般缓渗—速渗
荧光	0	肉眼看不见含油	为岩石本色或微黄色	无油脂感，不染手	一般闻不到原油味	滴水一般缓渗—速渗

4.1.2 缝洞性地层含油岩心含油级别的划分见表 2。

表 2 缝洞性地层含油岩心含油级别划分

含油级别	缝洞见原油情况
富含油	50%以上的缝洞见原油
油斑	50%以下的缝洞见原油
荧光	肉眼看不见含油，荧光滴照见显示

4.2 岩屑含油级别划分

4.2.1 孔隙性地层含油岩屑含油级别的划分见表 3。

表 3 孔隙性地层含油岩屑含油级别划分

含油级别	含油岩屑占定名岩屑百分含量 %	含 油 产 状	油 脂 感	味
富含油	>40	含油较饱满、较均匀，有不含油的斑块、条带	油脂感较强，染手	原油味较浓
油斑	5 ~40	含油不饱满，多呈斑块状、条带状含油	油脂感较弱，可染手	原油味较淡
油迹	>0~<5	含油极不均匀，含油部分呈星点状或线状分布	无油脂感，不染手	能够闻到原油味
荧光	0	肉眼看不见含油，荧光滴照见显示	无油脂感，不染手	一般闻不到原油味

4.2.2 缝洞性地层含油岩屑含油级别的划分见表 4。

表 4 缝洞性地层含油岩屑含油级别划分

含油级别	含油岩屑占定名岩屑百分含量 %
富含油	>5
油斑	>0~5
荧光	肉眼看不见含油，荧光滴照见显示

5 岩石定名及描述内容

5.1 定名

按颜色、含油级别、岩性（成分、结构、构造、化石及含有物）的顺序对岩石进行定名。当碎屑岩粒级无法确定时，可不必按其粒级定名，只定出岩石大类即可，如灰色砂岩、浅灰色灰质砂岩。

5.2 颜色

描述岩石新鲜面的颜色，并注意描述局部颜色变化情况。

5.3 成分

包括主要和次要矿物成分。取得薄片鉴定资料后，应对现场描述内容进行补充和修正。

5.4 结构

包括粒度、圆度、分选、结晶程度、晶粒大小、形状特征及相互关系、胶结物成分、胶结类型、胶结程度。

5.5 构造

包括层理类型、层面特征、冲刷面、缝合线、岩层倾角以及火成岩、变质岩的气孔、杏仁、流纹和片麻构造；节理、裂缝（类型、长度、宽度、密度、分布状态、充填程度、充填物矿物成分及其结晶程度）和孔洞（类型、大小、密度、连通性、充填程度、充填物矿物成分及其结晶程度）。

5.6 化石及含有物

包括化石的类型、大小、丰富程度、完好程度及分布状况；斑点、斑块、团块、结核的大小、成分、形状及分布状况。

5.7 物理化学性质

包括硬度、断口、光泽、气味、可溶性、水化膨胀、可塑性、可燃性和含灰质或白云质的情况。

5.8 含油情况

包括含油面积、含油产状、含油饱满程度、原油性质（轻质油、油质较轻、油质较稠、稠油）、油味（浓、较浓、淡、无）以及滴水（不渗、微渗、缓渗、速渗）和荧光显示情况。

5.9 含气情况

描述岩心浸水试验的气泡大小、密度、气味和冒气泡持续时间。

5.10 接触关系

包括渐变接触、突变接触、断层接触、不整合接触、整合接触、缝合线接触。

5.11 岩心孔洞缝的分类

5.11.1 孔洞大小分类见表 5。

表 5 孔洞大小分类

孔洞类别	孔 径 mm
巨洞	>100
大洞	>10~100
中洞	>5~10
小洞	1~5
针孔	<1

5.11.2 裂缝产状分类见表 6。

表 6 裂缝产状分类

裂缝类别	视倾角 (°)
立缝	>75
斜缝	15~75
平缝	<15

5.11.3 裂缝宽度分类见表 7。

表 7 裂缝宽度分类

裂缝类别	裂缝宽度 mm
巨缝	>10
大缝	>5~10
中缝	>1~5
小缝	>0.1~1
微缝	≤0.1

6 录井内容及要求

6.1 钻时录井

6.1.1 方法

6.1.1.1 采用综合录井仪、气测录井仪或其他录井仪器进行钻时录井。

6.1.1.2 根据钻达时间和停钻时间，计算单位进尺所用的纯钻进时间。

6.1.2 内容

6.1.2.1 井深、钻时。

6.1.2.2 放空起止时间、放空井段。

6.1.2.3 钻压、转速、泵压、排量、钻头直径及类型、起下钻井深、钻头蹩跳时间、蹩跳井段、下入钻头新度、起出钻头新度。

6.1.3 要求

6.1.3.1 钻具入井前应进行准确丈量并记录，单根钻具长度的单位为米，数值修约到二位小数。

6.1.3.2 井下钻具的种类、规格、钢印号、长度及其连接顺序应做到钻井与录井记录一致。

6.1.3.3 钻完每个单根后，录井仪器测量井深与钻具井深误差应不超过 0.2 m。

6.2 岩屑录井

6.2.1 迟到时间测量

6.2.1.1 测量间距见表 8。

表 8 迟到时间测量间距

井 深 m	测 量 间 距 m
≤1000	≤500
>1000~2000	≤200
>2000~3000	≤100
>3000	≤50

6.2.1.2 测量要求:

- 井深不大于 1000m, 实测不成功时可采用理论计算法求取迟到时间。
- 非气体钻井条件下使用颜色醒目的指示物实测迟到时间; 气体钻井条件下可采用注气法在钻头到底时实测迟到时间 (必要时, 可采用理论计算)。
- 指示物的密度应与岩屑接近, 且大小适中。
- 换用不同直径的钻头钻进时, 应重新测量迟到时间。

6.2.2 岩屑录取

6.2.2.1 岩屑录取时间应符合下列要求:

- 未停泵或变泵时, 按式 (1) 计算岩屑录取时间。

$$T_2 = T_3 + T_1 \quad \dots\dots\dots (1)$$

式中:

T_2 ——岩屑录取时间, 单位为时:分 (h:min);

T_3 ——钻达时间, 单位为时:分 (h:min);

T_1 ——岩屑迟到时间, 单位为时:分 (h:min)。

- 变泵时间早于钻达时间时, 按式 (2) 计算岩屑录取时间。

$$T_2 = T_3 + T_1 \cdot \frac{Q_1}{Q_2} \quad \dots\dots\dots (2)$$

式中:

T_2 ——岩屑录取时间, 单位为时:分 (h:min);

T_3 ——钻达时间, 单位为时:分 (h:min);

T_1 ——岩屑迟到时间, 单位为时:分 (h:min);

Q_1 ——变泵前的钻井液排量, 单位为升每分 (L/min);

Q_2 ——变泵后的钻井液排量, 单位为升每分 (L/min)。

- 变泵时间晚于钻达时间但早于岩屑录取时间时, 按式 (3) 计算岩屑录取时间。

$$T_2 = T_4 + (T_5 - T_4) \cdot \frac{Q_1}{Q_2} \quad \dots\dots\dots (3)$$

式中:

T_2 ——岩屑录取时间, 单位为时:分 (h:min);

T_4 ——变泵时间, 单位为时:分 (h:min);

T_5 ——变泵前录取时间, 单位为时:分 (h:min);

Q_1 ——变泵前的钻井液排量, 单位为升每分 (L/min);

Q_2 ——变泵后的钻井液排量, 单位为升每分 (L/min)。

6.2.2.2 岩屑采集应符合下列要求:

- 非气体钻井条件下, 应根据岩屑沉淀情况选择合适的取样位置, 采用垂直切捞法录取岩屑, 并在取完一包岩屑后立即清除剩余岩屑; 气体钻井条件下, 岩屑采样装置应安装在排砂管线斜坡段的下部, 使用透气的长条形布袋录取岩屑。
- 正常情况下, 起钻前应至少循环钻井液一周; 因工程原因无法循环钻井液时, 未捞出的岩屑应在下次下钻到底循环钻井液时进行补取。
- 录井间距应符合钻井地质设计书要求, 每包岩屑质量不应少于 500g。
- 岩屑录取后应立即清洗, 除去油污、泥饼和掉块后立即进行荧光检查, 并查找其他矿物, 确定岩性定名。细小和粉末状岩屑采用漂洗法清洗, 气体钻井条件下的岩屑不清洗。
- 岩屑清洗后应及时进行深度标识, 干燥后方可装袋。

6.2.3 岩屑描述

按 5.1~5.9 的规定进行描述 (肉眼无法辨识的现象除外), 并绘制比例尺 1:500 的岩屑录井草图。

6.2.4 采样

采样要求见 SY/T 6294。

6.2.5 岩屑现场保管及入库

6.2.5.1 岩屑经描述、采样后，应及时装盒（箱），并对岩屑盒（箱）进行标识。标识内容包括井号、盒号、井段、间距及包数。

6.2.5.2 岩屑盒（箱）应置于室内妥善保管，防止日晒、雨淋、受潮、鼠害、倒乱、丢失和污染。

6.2.5.3 完井后，填写岩屑入库清单，连同岩屑实物一并送交岩屑库。

6.3 钻井取心录井

6.3.1 岩心整理

6.3.1.1 岩心筒提出井口后，应丈量岩心筒内的顶、底空长度。

6.3.1.2 岩心出筒时，应保证岩心顺序不乱。

6.3.1.3 岩心出筒后，立即观察油气水现象，并对储集岩进行含气试验，记录油气水显示情况。

6.3.1.4 含油岩心、油基钻井液取心和密闭取心的岩心应使用刮刀或棉纱进行清洁处理，其他岩心则用水清洗干净。

6.3.1.5 将岩心按从左至右的顺序合理摆放在丈量台上（严重破碎岩心装袋后放置在相应位置）。

6.3.1.6 用红色记号笔在岩心上画出方向线，每个自然断块至少画一个箭头，箭头指向岩心底部。

6.3.1.7 用钢卷尺沿方向线一次性丈量岩心总长（单位为米，数值修约到二位小数），并用红铅笔每隔 0.5 m 画一个记号，写明岩心长度。

6.3.1.8 按式（4）、式（5）分别计算单筒和累计岩心收获率，数值修约到一位小数。

$$Y_D = \frac{L_D}{M_D} \times 100\% \quad \dots\dots\dots (4)$$

式中：

Y_D ——单筒岩心收获率，用百分数表示；

L_D ——单筒岩心长度，单位为米（m）；

M_D ——单筒取心进尺，单位为米（m）。

$$Y_\Sigma = \frac{\sum_{i=1}^n L_{ix}}{\sum_{i=1}^n M_{ix}} \times 100\% \quad \dots\dots\dots (5)$$

式中：

Y_Σ ——累计岩心收获率，用百分数表示；

$\sum_{i=1}^n L_{ix}$ ——累计岩心长度，单位为米（m）；

$\sum_{i=1}^n M_{ix}$ ——累计取心进尺，单位为米（m）。

6.3.1.9 用白漆在方向线上的半米、整米记号处涂出直径为 1.5 cm 的实心圆点，待漆干后用黑色记号笔（绘图墨汁）填写该点的距顶长度。必要时，也可使用半米、整米标签进行粘贴。

6.3.1.10 由顶至底在每一个自然岩心段上（每个装破碎岩心的袋子视为一个自然岩心段）用白漆涂出 3cm×2cm 的长方块，待漆干后用黑色记号笔（绘图墨汁）填写岩心编号。

6.3.1.11 按自浅至深、从左至右的顺序将岩心装入岩心盒，并对岩心盒进行标识。标识内容包括井号、取心筒次、井段、岩心编号及盒号。

6.3.1.12 在装入岩心盒的每筒岩心末端放置一块岩心挡板（若岩心收获率为零，则将挡板放置在岩心盒内相应位置），其上填写井号、取心筒次、取心井段、岩心长度、取心进尺、岩心收获率、主要岩性、岩心编号范围、取心日期、值班人。

6.3.2 岩心描述

按第 5 章的规定进行描述，并绘制比例尺 1：100 的岩心录井草图。

6.3.3 采样

采样要求见 SY/T 6294。

6.3.4 岩心现场保管及入库

6.3.4.1 岩心经描述、扫描、采样后，应及时装箱（盒）置于室内妥善保管，防止日晒、雨淋、受潮、鼠害、倒乱、丢失和污染。

6.3.4.2 完井后，填写岩心入库清单，连同岩心实物一并送交岩心库。

6.4 井壁取心录井

6.4.1 岩心整理

6.4.1.1 取心枪提出井口后，依次对号取出岩心，并对岩心进行编号。岩心有效长度小于 10 mm 者，视为无效岩心。

6.4.1.2 记录取心深度、设计取心颗数、实际取心颗数、含油气岩心颗数。

6.4.2 岩心描述

描述内容见第 5 章。

6.4.3 采样

采样要求见 SY/T 6294。

6.4.4 岩心包装入库

6.4.4.1 岩心经描述、采样后，应及时填写井壁取心标签（包括序号、井号、井深、岩性）连同岩心一并装入井壁取心瓶（盒）内。

6.4.4.2 井壁取心结束后，填写井壁取心描述记录，连同岩心实物一并送交相应部门。

6.5 荧光录井

6.5.1 岩屑、岩心、井壁取心样品应进行荧光湿照、干照和滴照，并按 SY/T 6611 的规定进行定量荧光分析。

6.5.2 荧光分析所使用的工具、材料和试剂应无荧光显示

6.6 钻井液录井

6.6.1 资料收集

6.6.1.1 钻井液性能资料：钻井液类型，测点井深、相对密度、粘度、失水、泥饼、切力、pH 值、含砂、氯离子含量。

6.6.1.2 钻井液处理资料：时间、井深，处理剂的名称、用量及其对荧光录井背景值的影响。

6.6.1.3 槽面显示资料包括：

- a) 出现显示时的井深、钻井液迟到时间，显示的起、止时间及高峰时间，显示类型，钻井液相对密度、粘度和颜色变化情况。
- b) 原油的颜色、分布状态（如片状、条带状、星点状）及占槽面百分比。
- c) 气泡的大小、形状（针孔状、小米状）、分布状态（密集、稀疏）及占槽面百分比。
- d) 油气味类型（如芳香味、H₂S 味）和气味浓烈程度（浓、较浓、淡、无）。
- e) 槽面上涨情况和槽内钻井液流动状态。
- f) 外溢的时间、速度、液量。
- g) 取气体样品做点火试验的可燃性（可燃、不燃）和燃烧现象（火焰颜色、高度）。
- h) 后效显示的钻头位置、钻井液静止时间、开泵时间及油气上窜速度。

6.6.1.4 井涌（喷）资料包括：

- a) 井涌（喷）：高度、涌（喷）出物（油、气、水）、夹带物（如钻井液、砂泥、砾石、岩块）及其大小，进、出口流量变化和间歇时间。
- b) 节流管放喷：放喷管尺寸、压力变化、射程、喷出物（油、气、水）及放喷起、止时间。
- c) 井喷或放喷量（根据井喷或放喷起、止时间及油、气、水喷出总量折算成日产量）。

d) 井涌（喷）的处理方法、压井时间、加重剂名称及用量，井喷前和压井后的钻井液性能以及放喷点火情况。

e) 井涌（喷）原因。

6.6.1.5 井漏资料包括：

a) 发生井漏的井深、层位、岩性、钻头位置、工作状态（如钻进、循环钻井液），井漏的起、止时间及漏失量、漏速。

b) 处理方法、堵漏时间、处理剂名称及用量，井漏前和处理后的钻井液性能。

c) 井漏的原因及影响录井资料录取的情况。

6.6.2 油、气、水取样

发生油、气、水侵和井涌（喷）时，应按 SY/T 6294 的规定采集油、气、水分析样。

6.7 其他资料收集

6.7.1 井位资料包括：

a) 地理位置、构造位置、测线位置、井别、井型、纵坐标、横坐标、地面海拔、补心海拔、补心高。

b) 海上增加井位坐标的经纬度及水深。

6.7.2 井身资料包括：

a) 开钻日期、完钻日期、完井日期、设计井深、完钻井深、完钻原则、完钻层位、完井方法以及钻头尺寸、类型和钻达井深。

b) 套管：产地、尺寸、钢级、壁厚、总根数、总长度、下深、联入、套补距、引鞋、阻流环位置、短套管位置、扶正器位置、尾管喇叭口位置、筛管结构及位置，不同壁厚、钢级的套管分段长度及其下深。

c) 固井：水泥牌号、标号、用量，注水泥时间、水泥浆类型及相对密度（最大、最小、平均）、注水泥浆泵压、替钻井液时间、钻井液替入量、钻井液相对密度及粘度、替钻井液泵压、碰压压力、漏失情况，试压时间、试压压力、压力下降情况，水泥返深（设计和实际）、水泥塞面顶深、固井质量（优、合格、不合格）及其井段。

d) 井身轨迹：

1) 直井：测斜点的深度、井斜、方位，全井最大井斜点的深度、井斜、方位，全井井斜变化率及全角变化率，井底总水平位移及总方位，油气层段顶、底总水平位移及总方位，测斜方式。

2) 定向井：测斜点的深度、井斜、方位，造斜点和降斜点的深度及全角变化率，井底总水平位移、总方位及垂直井深，主要目的层顶、底的总水平位移、总方位、垂直井深、靶心距（因工程事故所进行的侧钻也应有相应的井斜资料），测斜方式。

3) 水平井：增斜点的全角变化率，水平段入口点的井深、井斜、方位、曲率半径，水平段投影长度以及定向井规定的其他资料项目。

6.7.3 测井作业简况包括：

a) 测井作业的类型（如中途、完钻、完井、固井质量检查、VSP 测井）、日期、测时井深、层位。

b) 测井项目、比例尺、井段。

c) 测井事故及其原因和处理情况。

6.7.4 测试作业简况包括：

a) 测试作业的方式（如悬挂、支撑、跨隔、测—射联作）、日期、井深、层位、井段、测试器型号。

b) 封隔器位置、筛管位置，内、外压力计位置，测试器位置。

- c) 坐封、开关井、解封和起钻时间。
- d) 压井液、液垫类型及数量，掏空高度、容积。
- e) 测试成果、回收物性质（油、水、混浆）及数量，折算日产量。

6.7.5 特殊钻井作业简况包括：

- a) 特殊钻井作业类型（如气体钻井、泡沫钻井、欠平衡钻井）、日期、井段、层位。
- b) 特殊钻井循环介质的类型、性能参数，影响录井资料情况。
- c) 特殊钻井作业中止的原因及处理情况。

6.7.6 工程大事简况包括：

- a) 卡钻：井深、时间、钻头位置、卡点深度、卡钻类型（如盐卡、粘卡）、卡钻原因及处理（如泡油、泡酸、泡解卡剂、上下震击、套铣、爆炸松扣）情况。
- b) 井壁坍塌：井深、时间，坍塌的井段、层位、原因及处理情况。
- c) 断钻具、落物：井深、时间，落物的结构、长度及所在井段，落物的原因及处理情况。
- d) 钻具刺穿：井深、时间、钻头位置、泵压变化、钻具刺穿位置及处理情况。
- e) 顿钻：井深、时间、钻头位置、顿钻原因及处理情况。
- f) 填井侧钻：裸眼侧钻的水泥塞顶面深度，侧钻的井深、层位、井斜、方位、原因；开窗侧钻的斜向器位置，开窗的井深（上窗点、下窗点）、层位、井斜、方位、套管尺寸及下深。

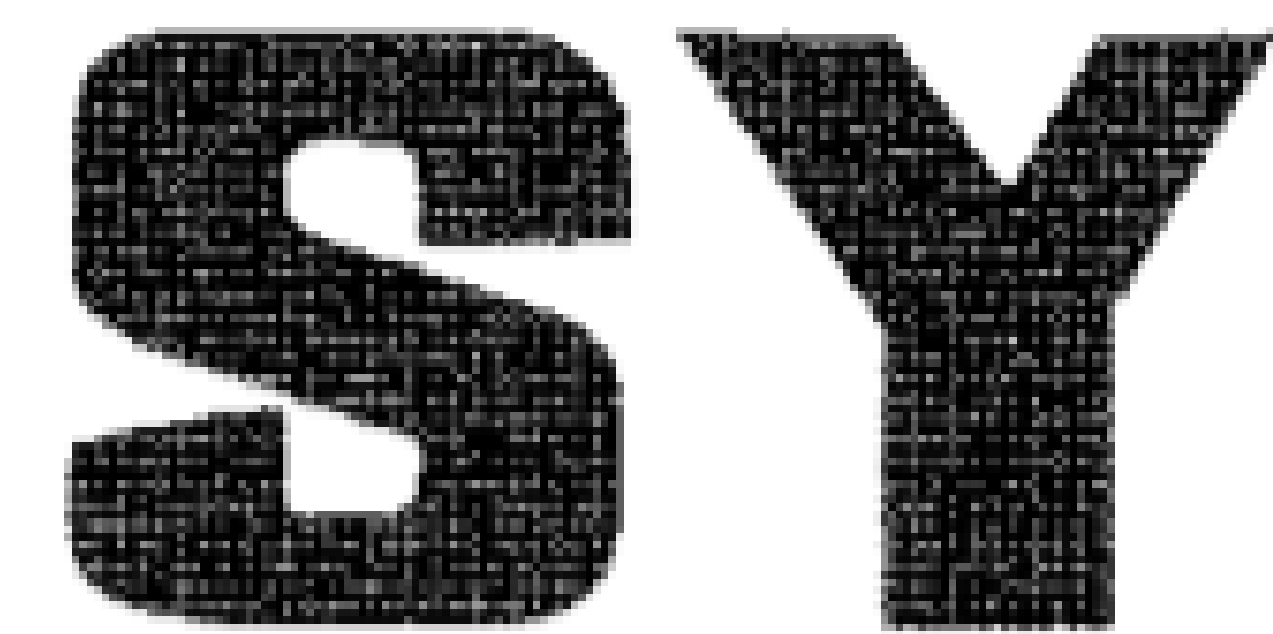
7 资料项目

- a) 钻井地质设计书（包括补充及更改设计书）。
- b) 地质观察记录。
- c) 地质原始综合记录（含荧光记录、钻时记录）。
- d) 岩屑描述记录。
- e) 岩心描述记录。
- f) 井壁取心记录。
- g) 地质日志。
- h) 钻井液氯离子分析记录。
- i) 套管记录；
- j) 岩屑录井草图；
- k) 岩心录井草图；
- l) 油砂代表样。
- m) 井壁取心样。
- n) 岩屑实物剖面。

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Standard for the Petroleum and Natural Gas Industry

SY/T 5788. 3—2008

Replace SY/T 5788. 3—1999

**Specifications for geological logging of
oil and gas wells**

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Contents

Foreword	14
1 Scope	15
2 Normative references	15
3 Conditions of geological logging	15
4 The classification of oil – bearing grade	15
5 Rock denomination and content of description	17
6 The content of geological logging and requirements	18
7 List of data	24

Foreword

This standard has been revised based on the SY/T 5788.3—1999 *Geological logging specification for oil and gas wells*.

This standard, in comparison with SY/T 5788.3—1999, has the following main differences:

- Changed the title of this standard to *Specifications for geological logging of oil and gas wells*;
- Revised partial content of Chapter 2, Chapter 3, Chapter 4, Chapter 5 and Chapter 6;
- Deleted Annex A and Annex B of SY/T 5788.3—1999;
- Added the content of *Summary of special drilling operations* and Chapter 7

This standard is proposed by and under the jurisdiction of the Technical Committee of Standardization for Petroleum Geological Exploration. This standard is drafted by Well Logging Company of Jiangnan Petroleum Administration; Ge-

ologging Company of Liaohe Petroleum Exploration Bureau; Geologging Division of Zhongyuan Oilfield Company Ltd; Geologging Company of North China Petroleum Administration.

The main drafters of this standard are Xu Liuchai, Ye Yinggui, Hu Duanyi, Zhou Xiaochun, Zeng Yongwen, Liu Zhigang and Chen Yingyi.

This standard replaces all of the previous versions as follows:

- SY 5090—1985;
- SY 5364—1989;
- SY 5365—1989;
- SY/T 5788.3—1993; SY/T 5788.3—1999;
- SY/T 6157—1995。

This standard is published in both Chinese and English. In the event of any discrepancy between the texts, the Chinese version shall prevail.

Specifications for geological logging of oil and gas wells

1 Scope

This standard specifies the content, operation flow, methods and requirements of the geological logging for oil and gas wells.

This standard is applicable to the geological logging for oil and gas wells.

2 Normative references

The following normative documents contain provisions which, through reference in this standard, constitute provisions of this standard. For dated references, subsequent amendments to, or revisions of, any of these publications (exclude errata) do not apply. However, parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies.

SY/T 6294 *The wellsite sampling specifications for geological logging sampling analysis*

SY/T 6611 *Technical specification for quantitative fluorescence analysis*

3 Conditions of geological logging

3.1 A surge tank shall be added to the elevated duct of the mud return line, which shall meet geological logging requirements.

3.2 The fresh water hose for flushing cuttings is connected to the sampling site and the water should be clean and available any time.

3.3 The shale shaker shall be in good condition and meet cuttings requirements. The explosion proof lamps shall be mounted along the side of the shale shaker.

3.4 The mud logging cabin shall be powered through a dedicated line with voltage of $380\text{V} \pm 38\text{V}$ and frequency of $50\text{Hz} \pm 2\text{Hz}$; the geologist's cabin and the cuttings storeroom shall be powered with voltage of $220\text{V} \pm 22\text{V}$ and frequency of $50\text{Hz} \pm 2\text{Hz}$.

4 The classification of oil-bearing grade

4.1 The classification of core oil-bearing grade

4.1.1 The classification of core oil-bearing grade for porous rocks is given in Table 1.

Table 1 The classification of core oil-bearing grade for porous oil-bearing rocks

Oil-bearing grade	Percentage of the oil-bearing area accounting for the total area of the rock, %	Oil-bearing saturation degree	Color	Grease sense	Odor	Wettability
Full oil-bearing	>95	Full oil-bearing, uniform, non-oil-bearing speckles and strips in part	Brown, dark brown, nut. Brown, sepia, black brown, no sight of rock natural color	Strong grease sense, hand stained	Strong crude oil odor	Ballpoint shape, no wet

Table 1 (continue)

Oil-bearing grade	Percentage of the oil-bearing area accounting for the total area of the rock, %	Oil-bearing saturation degree	Color	Grease sense	Odor	Wettability
Rich oil-bearing	>70~95	Relatively full oil-bearing saturation and uniform, with non-oil-bearing patches and strips	Brown, light brown, yellow brown, brown yellow, sight of rock natural color in non-oil-bearing parts	Strong grease sense, hand stained	Strong crude oil odor	Ballpoint shape, no wet
Oil stain	>40~70	Less than full oil-bearing saturation, striped and spotted oil-bearing non-uniform distribution	Light brown, yellow gray, brown gray, no sight of rock natural color in oil-bearing parts	Weak grease sense, hand stained	Slight odor of crude oil	Drops present a shape of half bead
Oil patch	5~40	Less than full of oil-bearing saturation, non-uniform, mainly striped and spotted oil-bearing	Predominantly natural color of rock	Weak grease sense, hand stained	Very slight crude oil odor	Drops present a shape of half bead, slightly wet
Oil trace	>0~<5	Extreme non-uniform of oil-bearing, stellate or linear oil distribution in oil-bearing parts	Natural color of rock	No grease sense, no hand staining	With smell of crude oil odor	Slow dropping, wet
Fluorescence	0	No visible oil	Natural color of rock or light yellow	No grease sense, no hand staining	Generally no smell of crude oil odor	Slow dropping, wet

4.1.2 The classification of core oil-bearing grade

for fractural and vuggy rocks is given in Table 2.

4.2 The classification of cuttings oil-bearing

grade

4.2.1 The classification of cuttings oil-bearing

grade for porous rocks is given in Table 3.

Table 2 The classification of core oil-bearing grade for fractured and vuggy rocks

Oil-bearing grade	Crude oil indication on the walls of fractures and vug
Oil-bearing	More than 50% indication of crude oil on the walls of fractures and vug
Oil patch	Less than 50% indication of crude oil on the walls of fractures and vug
Fluorescence	No oil indication; there is a cut fluorescence show

Table 3 The classification of cuttings oil-bearing grade for porous rocks

Oil-bearing grade	Mass percentage of the oil cuttings accounting for the designated cuttings %	Oil-bearing occurrence	Grease sense	Odor
Oil-bearing	>40	Relatively full oil-bearing saturation and uniform, with non-oil-bearing patches and strips	Strong grease sense, hand stained	Strong crude oil odor
Oil patch	5~40	Less full oil-bearing saturation, non-uniform, mainly striped and spotted oil-bearing	Weak grease sense, hand stained	Slight odor of crude oil
Oil trace	>0~<5	Extremely non-uniform of oil-bearing, stellate or linear oil distribution in oil-bearing parts	No grease sense, no hand staining	With smell of crude oil
Fluorescence	0	No indication of oil; there is a fluorescence show after cutting the sample	No grease sense, no hand staining	Generally no smell of crude oil

4.2.2 The classification of cuttings oil-bearing grade for fractural and vuggy rocks is given in Table 4.

5 Rock denomination and content of description

5.1 Denomination

The rock is named according to the order of col-

or, oil-bearing grade and lithology (composition, texture, structure, fossil and accessories) . When the grain size grade of a clastic rock fails to be determined, it can be named only in the major rock class and not in the grain size grade instead, such as grey sandstone and light-grey lime sandstone.

Table 4 The classification of cuttings oil-bearing grade for fractured and vuggy rocks

Oil-bearing grade	Percentage of the oil cuttings accounting for the designated cuttings %
Oil-bearing	>5
Oil patch	>0~5
Fluorescence	No indication of oil; there is a cut fluorescence show

5.2 Color

The color of a fresh surface of the rock as well as its local color change shall be described.

5.3 Composition

Including the primary and minor mineral components. The onsite description content shall be

supplemented and modified instantly after obtaining the results of thin section analysis.

5.4 Texture

Including grain size, bounding, sorting, degree of crystallization, grain size, shape feature as well as correlation, components of cementing

material, cementation type and degree of cementation.

5.5 Structure

Including bedding type, bedding plane features, erosion surface, stylolite, rock dip and air pores, amygdaloid, rhyolite, gneissose of igneous and metamorphic rocks; joints, fractures (type, length, width, density, distribution status, filling degree, filling mineral component and crystallization), vug (type, size, connectivity, density, filling degree, filling mineral component and crystallization).

5.6 Fossil and accessories

Including fossil type, size, abundance, roundness and distribution, spot, patch, agglomerate and nodules (size, component, shape and distribution).

5.7 Physical and chemical properties

Including hardness, fracture, lustre, odor, dissolvability, hydration swelling and plasticity, flammability, lime or dolomitic features.

5.8 Oil-bearing features

Including oil-bearing area, oil-bearing occurrence, saturation; properties of the crude oil (light oil, relatively light oil; relatively heavy oil, heavy oil), oil odor (thick, relatively thick, slight, null), wettability (no wet, slightly wet, slowly wet, wet) and fluorescence.

5.9 Gas-bearing features

The size, density, odor and bubbling time of gas bubbles during the water immersion test of the core.

5.10 Contact relationship

Including transition relationship, abrupt relationship, faulted contact, unconformable contact, conformable contact and stylolite contact.

5.11 The classification of pores, vug and fractures of the core

5.11.1 The size classification of vug (see Table 5).

5.11.2 The occurrence classification of fractures (see Table 6).

5.11.3 The width classification of fractures

(see Table 7).

Table 5 The size classification of vug

Type (category) of vug	Diameter of vug mm
Huge vug	>100
Large vug	>10~100
Medium vug	>5~10
Tiny vug	1~5
Pinhole	<1

Table 6 The classification of fractures

Type of fracture	Apparent dip angle (°)
Vertical fracture	>75
Slanting fracture	15~75
Flat fracture	<15

Table 7 The width classification of fractures

Type of fracture	Width mm
Micro-fracture	≤0.1
Tiny fracture	>0.1~1
Medium fracture	>1~5
Large fracture	>5~10
Huge fracture	>10

6 The content of geological logging and requirements

6.1 Drilling rate logging

6.1.1 Method

6.1.1.1 One of the comprehensive mud logging unit, gas logging unit and drilling rate logging unit shall be used to perform drilling rate logging.

6.1.1.2 The actual drilling time against the drilling footage is calculated based on the drilling arrival time and the drilling break time.

6.1.2 Content

6.1.2.1 Well depth and rate of penetration.

6.1.2.2 Start-stop time and depth interval for the drilling break.

6.1.2.3 Weight on bit, rotary speed, pump pressure, pump discharge capacity, bit diameter and type, trip depth, bouncing time, bouncing interval, trip-in bit grade and trip-out bit grade.

6.1.3 Requirements

6.1.3.1 Drilling tools shall be measured accurately and recorded before running in. The length of each joint shall be in meter and accurate to two decimal points.

6.1.3.2 The types, specifications, steel seal numbers, length and connection order of the down-hole tools shall be in accordance with those of the engineering and geological records.

6.1.3.3 After each single joint is run for drilling, the error between the depth displayed on the logging unit and that of the drilling tool shall not be over 0.2m.

6.2 Cuttings logging

6.2.1 Measurement of lag time

6.2.1.1 Interval of measurement of lag time (see Table 8) .

Table 8 Interval of lag time measurement

Well depth m	Interval of measurement m
≤1000	≤500
>1000~2000	≤200
>2000~3000	≤100
>3000	≤50

6.2.1.2 Measurement requirements:

- If the depth is less than 1000m and the actual measurement fails to be made, a theoretical calculation can be chosen.
- The indicator such as eye-catching ceramic fragments or dyed cuttings is used to measure lag time of cuttings under the condition of fluid drilling; a gas injection method with the drill bit at the well bottom is used to measure lag time of cuttings under the condition of gas drilling (or using the theoretic calculation if necessary) .

- The indicator shall be close to the cuttings in density and moderate in size.
- When a different bit diameter is changed for drilling, lag time shall be measured anew.

6.2.2 Catching of cuttings

6.2.2.1 Time for catching cuttings shall be in accordance with following requirements:

- Time for catching of cuttings can be determined using Equation (1), while the pump is not stopped or not changed .

$$T_2 = T_3 + T_1 \quad \dots\dots (1)$$

Where:

T_2 —Time for catching of cuttings, h : min; .

T_3 —Time of drilling to destination, h : min;

T_1 —Lag time of cuttings, h : min.

- Time for catching of cuttings can be determined according to Equation (2) when the time of pump change is ahead of the time of drilling to destination.

$$T_2 = T_3 + T_1 \cdot \frac{Q_1}{Q_2} \quad \dots (2)$$

Where:

T_2 —Time for catching of cuttings, h : min;

T_3 —Time of drilling to destination, h : min;

T_1 —Lag time of cuttings, h : min;

Q_1 —Discharge amount of drilling fluid before the pump changes, L/min;

Q_2 —discharge amount of drilling fluid after the pump changes, L/min.

- Time for catching of cuttings can be determined according to Equation (3) when the time of pump change is behind that of drilling to destination, but ahead of that of catching the cuttings .

$$T_2 = T_4 + (T_5 - T_4) \cdot \frac{Q_1}{Q_2} \quad \dots\dots (3)$$

Where:

T_2 —Time for catching of cuttings, h : min;

T_4 —Time of pump change, h : min;

T_5 —Time of catching cuttings before the pump changes, h : min.

Q_1 —Discharge amount of drilling fluid before the pump changes, L/min;

Q_2 —discharge amount of drilling fluid after the pump changes, L/min.

6.2.2.2 Requirements for catching of cuttings;

- a) Under the condition of drilling fluid, cuttings shall be caught by the vertical cutting method at the moderate position selected based on buildup of the cuttings, and the remaining cuttings shall be cleaned immediately after the catching of one pack of cuttings. Under the condition of gas drilling, the sampling unit shall be installed at the lower slope section of sand drainage line and the cuttings shall be caught by an elongated and ventilated cloth bag.
- b) Normally, the drilling fluid shall be circulated for one bottoms-up before tripping out. When the bottoms-up circulation fails to be performed due to the side of engineering, the un-caught cuttings shall be re-caught next time after running back to bottom and circulating the drilling fluid again.
- c) Logging interval shall be taken in accordance to the geological design. The weight of every pack of cuttings shall not be less than 500g.
- d) The cuttings shall be cleaned to remove oil stains, mud cakes and cavings immediately after catching, and to perform fluorescence checking and discover oil-bearing cuttings and other mineral pieces, and to determine lithology and names. If the cuttings are fine or powder-like, the fulling method is used to clean the cuttings. Under the condition of gas drilling, the cuttings are not cleaned.
- e) The cuttings shall be given depth marks instantly after cleaning and be dried before they are bagged.

6.2.3 Description of cuttings

Description of cuttings is implemented according to the relevant regulations of 5.1~5.9 (excluding what is not identified by naked eyes) and a

log of cuttings with a scale of 1 : 500 shall be drawn during logging.

6.2.4 Sampling

Sampling is implemented in accordance to the relevant regulations of SY/T 6294.

6.2.5 Cuttings' storage on site and warehousing

6.2.5.1 After description and sampling, cuttings shall be boxed (encased) in time and marked. The content of marks includes well name, tray number, depth interval, interval and pack number.

6.2.5.2 The cuttings box shall be placed indoors to isolate against insolation, rain, moisture, rat damage, messing up, loss and contamination.

6.2.5.3 A cuttings warehousing list shall be filled out and handed over to the cuttings warehouse keeper together with all of the cuttings after well completion.

6.3 Coring logging

6.3.1 Treatment of cores

6.3.1.1 After the core barrel is pulled out of the hole, both the length of top and bottom space inside the barrel shall be measured.

6.3.1.2 Ensure the core in good order when it is taken out of the barrel.

6.3.1.3 Oil, gas and water shows of the core shall be observed and recorded immediately after it is taken out of the barrel based on a gas-bearing test on the reservoir rock.

6.3.1.4 Cores taken from both the oil-base mud drilling fluid and the sealed coring shall be cleaned with the scraper or cotton yarn rather than flushed with water.

6.3.1.5 Cores shall be placed on the measuring table in proper order from left to right. Badly broken cores shall be bagged and placed in proper position.

6.3.1.6 A directional line shall be drawn with a red marker on the core. An arrowhead on each naturally broken piece is drawn with the arrowhead pointing to the bottom of the core.

6.3.1.7 The total length of the core shall be

measured at one time along the directional line using a steel tape (unit in meter, accurate to two decimal points), and marked every half meter with the core length using a red pencil.

6.3.1.8 Core recovery for a single barrel and cumulative core recovery shall be calculated separately according to Equation (4) and Equation (5) (accurate to one decimal point).

$$Y_D = \frac{L_D}{M_D} \times 100\% \quad \dots (4)$$

Where;

Y_D —Core recovery for a single barrel, %;

L_D —Core length for a single barrel, m;

M_D —Core footage for a single barrel, m.

$$Y_\Sigma = \frac{\sum_{i=1}^n L_{D_i}}{\sum_{i=1}^n M_{D_i}} \times 100\% \quad \dots\dots (5)$$

Where;

Y_Σ —Cumulative core recovery, %;

$\sum_{i=1}^n L_{D_i}$ —Cumulative core length, m;

$\sum_{i=1}^n M_{D_i}$ —Cumulative core footage, m.

6.3.1.9 Along the directional line on the core, a diameter of 1.5 cm round mark is painted every half meter and one meter using white paint. After the paint is dry, the distance to the core's top is marked inside the round mark using a black marker (drawing ink). If necessary, a label with half meter or one mark can be stuck to the above-mentioned position.

6.3.1.10 A square mark of 3cm × 2cm shall be painted with white paint on each natural core segment from the top to the bottom (each bag of naturally broken core pieces is regarded as one natural core segment). After the paint is dry, the core serial number is written down on the square mark with a black marker (drawing ink).

6.3.1.11 The cores shall be put in the core tray according to the order from shallowest to deepest, from left to right, and the marks on the inside wall of the core tray shall be painted. The content of marks on the core tray include; well

name, tray number, coring barrel number, depth interval and tray number.

6.3.1.12 The end plate shall be placed at the end of the core for each single barrel (when the recovery of core is zero, the end plate shall be put in the corresponding position in the core tray), with the well name, coring barrel number, depth interval, core length, coring footage, core recovery, lithology, range of core number, date of coring and person on duty.

6.3.2 Core description

Cores shall be described according to the stipulations of Chapter 5. A draft core log shall be drawn at a scale of 1 : 100.

6.3.3 Sampling

Sampling is made according to the regulations of the standard SY/T 6294.

6.3.4 Core storage on site and in the warehouse

6.3.4.1 After description and sampling, cores shall be boxed in time and placed indoors to isolate against rain, moisture, rat damage, disturbance, loss and contamination etc.

6.3.4.2 After well completion, the core warehouse inventory shall be filled up and handed over to the core warehouse keeper.

6.4 Sidewall coring

6.4.1 Treatment of sidewall cores

6.4.1.1 After the coring gun is out of the hole, each complete core shall be taken out in turn and marked with a serial number. A core with an effective length of less than 10mm is regarded as an invalid core.

6.4.1.2 Recording the coring depth, designed number of cores, actual number of cores and number of hydrocarbon-bearing cores.

6.4.2 Core description

The content of core description is referred to Chapter 5.

6.4.3 Sampling

Sampling is made in accordance with the regulations of the standard SY/T 6294.

6.4.4 Core packing and in the warehouse

6.4.4.1 After sampling and description, the

sidewall cores shall be put into the coring bottle with the labels that are filled up. The label shall be marked with the serial number, well number and depth.

6.4.4.2 The coring record shall be filled up after sidewall coring and handed over with the cores to the corresponding department.

6.5 Fluorescence logging

6.5.1 Wet cut, dry cut and streaming cut shall be done on the cuttings, cores and sidewall cores and a quantitative fluorescence analysis shall be made as per the regulations of the standard SY/T 6611.

6.5.2 No fluorescence show shall be ensured on all of the filter paper, test tube, solvent and mortar.

6.6 Drilling fluid logging

6.6.1 Collection of data

6.6.1.1 Data for drilling fluid properties: type, depth of measuring point, density, viscosity, water loss, mud cake, shear force, pH value, sand content and chloride ion content.

6.6.1.2 Data for drilling fluid treatment: time, depth, name and quantity of the additive and its effect on the fluorescence logging background value.

6.6.1.3 Data for ditch line shows include:

- a) Depth of show, lag time, time of show, peak duration, dying-out time, show type, drilling fluid density, viscosity and color change.
- b) Crude oil color, distribution status (flaky, streaky and asteroid) and percentage of occupying the ditch line.
- c) Bubble size, shape (pinhole and millet), distribution status (dense and sparse), percentage of occupying the ditch line.
- d) Odor type of oil and gas (aromatic, H_2S odor), odor intensity (strong, medium strong, weak, none).
- e) Gaining of ditch line level and drilling fluid flow status inside the ditch line.
- f) Overflow (overflow time, volume, and overflow speed).
- g) Gas flame test; flammability (flammable, inflammable), and burning state (flame color,

height).

- h) For the re-circulating gas show, bit depth, drilling fluid resting time, pump on time and the up-running speed of oil and gas shall be recorded.

6.6.1.4 Data for kick and blowout include:

- a) Kick and blowout; height, blowout (gushed) entrainment (oil, gas and water), entrainment out with (drilling fluid, silt and clay, gravel, rock pieces, etc) and size, change between mudflow in and out, rest time.
- b) Blowoff through choke manifold; blowoff pipe size, pressure change, blowoff distance, material (oil, gas and water) and start-stop time.
- c) Blowout or blowoff amount; it shall be converted into the daily production according to the blowout or blowoff start-stop time and the total amount of erupted oil, gas and water.
- d) Method for dealing with kick and blowout, kill hour, names and quantities of weight additives, drilling fluid properties before blowout and after killing, and blowoff and flame test status.
- e) Reasons that cause the kick and blowout.

6.6.1.5 Data for lost circulation include:

- a) The depth, horizon, lithology, bit depth, working state (such as drilling, circulating drilling fluid), loss start-stop time, amount and loss velocity during the lost circulation.
- b) Method for dealing with lost circulation, blocking hour, names and amounts of additives, drilling fluid properties before the lost circulation and after treatment.
- c) Reasons that cause lost circulation and influence of recording the logging data.

6.6.2 Sampling of oil, gas and water

When there is an influx of oil, gas and water as well as a kick and blowout, samples of oil, gas, water shall be taken according to the regulations of the standard SY/T 6294.

6.7 Collection of other information

6.7.1 Data of well location include:

- a) Geographic location, structural location, the location on seismic line, well category, well type, horizontal ordinate, longitudinal ordinate, ground elevation, rotary Kelly bushing and bushing height,
- b) Latitude and longitude of the location co-ordinate and water depth shall be added for the offshore well.

6.7.2 Data of well bore structure include:

- a) Spud date, finished drilling date, completion date, designed depth, final depth, principle of finishing drilling, horizon at the final depth, completion method and bit size, type and depth drilled to.
- b) Casing: manufacturer, size, grade of steel, wall thickness, total joints, total length, total setting depth, length of landing joint, casing bushing distance, guide shoe, float collar position, short casing joint position, centralizer position, bell nipple position of liner, structure and position of screen, the length and relevant set depth with different wall thickness and steel grade (i. e. the casing running program) .
- c) Cementing: cement brand, grade and amount, cementing start-stop time, cement slurry (paste) type and density (max. min. and average), cementing pump pressure, time of displacing drilling fluid, displacement of drilling fluid, drilling fluid density and viscosity, pump pressure of displacing drilling fluid, loss of drilling fluid, time for bumping and testing pressure, test pressure, pressure drop, cement return (prognosis and actual) depth, top depth of cement plug, cement quality (excellent, qualified and failure) and depth interval.
- d) Well bore trajectory:
 - 1) Vertical well: depth of deviation survey, deviation angle and azimuth at the measuring point, measured depth, deviation

angle and azimuth of the whole well at the maximum inclination point, severe degree of dog leg, rate of overall angle change, overall horizontal shift (displacement), overall azimuth, overall horizontal shift and overall azimuth at the top or bottom of the hydrocarbon interval.

- 2) Directional well: depth, angle of inclination and azimuth at the measuring point. Depth and rate of angle change and azimuth at the kick-off point and drop-off point, overall horizontal shift, overall azimuth and vertical depth at the bottom, overall horizontal shift, overall azimuth, vertical depth and distance of target center at the top or bottom of the primary target interval (There shall be relevant deviation data if the sidetrack drilling is a necessity due to engineering accidents), survey mode.
- 3) Horizontal well: such data shall also be collected as rate of overall angle change at the build-up point, depth, deviation angle and azimuth at the entry point of horizontal section, radius of curvature, projected length for the horizontal section and other data that the directional well requires.

6.7.3 Summary of well logging:

- a) Type of well logging (mid-course logging, completion logging, cement bond logging and VSP), date, depth recorded while measuring, and horizon.
- b) well logging item, scale, and depth interval.
- c) well logging accident and cause, processing.

6.7.4 Summary of well testing:

- a) Operation methods of well testing (hanging, support, straddle and TCP), date of testing, depth, horizon, depth interval, type of testing tool.
- b) Packer location, screen position, external pressure gauge position, internal pressure gauge position, and tester position.
- c) Packing, opening and shutting in, unpacking

and pulling-out time.

- d) Well killing fluid, fluid cushion type and quantity; emptying height and volume.
- e) Testing results and properties of retrieved material (oil, water and mixture), quantity, converted daily production.

6.7.5 Summary of special drilling:

- a) Category of special drilling operations (gas drilling, foam drilling and under-balanced drilling), date, hole interval and horizon.
- b) types and performance parameters of special drilling circulating media, and their effects on log data.
- c) Cause, treatment measure and result for special drilling failure.

6.7.6 Summary of engineering accidents:

- a) Sticking; depth, time and cause of sticking, bit depth of sticking, depth at sticking point, sticking type (salt sticking and differential sticking), sticking cause and treatment (oil soaking, acid soaking, release agent soaking-soaking with black magic or soaking with pipe lax material, upward and downward jarring, wash over, and explosion for thread freeing) .
- b) Cavings; depth, time, depth interval and horizon of the cavings, cause and treatment.
- c) Broken tools and downhole junks; depth, time, composition of junk, length and depth interval of the downhole junks, cause and treatment.
- d) Piercement of drilling tools; well depth,

time, bit depth, variation of pump pressure, piercement depth of the drill tools and treatment.

- e) Cable drilling; depth, time, bit depth, cause and treatment.
- f) Plug-back sidetracking: top cement plug depth of sidetracking in openhole, depth at sidetracking point, horizon, azimuth, deviation and sidetracking reason; whipstock depth of window cutting sidetracking, depth of window cutting (upper window point and lower window point), horizon, azimuth, deviation, casing size and setting depth.

7 List of data

- a) Well Geological design (including supplement and design change) .
- b) Geological observational records.
- c) Geological original comprehensive records (Fluorescence record and drill time records) .
- d) Cutting description records.
- e) Core description records.
- f) Sidewall coring records.
- g) Geological daily logs.
- h) Drilling fluid Chloride analytic records.
- i) Casing records.
- j) Draft cutting logs.
- k) Draft core logs.
- l) Oil sand samples.
- m) Sidewall coring samples.
- n) Cutting sections.

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