FIELD ELECTRICAL SYSTEMS

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SUMMARY

It is important that all electrical contractors on location perform quality work. The end product of their work must meet OSHA regulations, NEC and API code standards. OSHA regulations are enforced by the federal government, whereas, industrial codes do not generally have the force of regulations. Reduction of field operating expenses will be achieved by upgrading the electrical systems. Better electrical systems will reduce field downtime and this will generate more production. During the electrical upgrades, all deenergized powerlines must have a phase-phase fault and a phase-ground fault established. These faults change the characteristics of the powerline, which is an OSHA regulation. The major cause of damage to electrical equipment is incorrect fuse sizing and improperly wired control panels. An alternative to relocating powerlines is to place fused cutouts with attached lightning arrestors on the conductors. This will allow the powerline to be deenergized during well workovers. Upgrading the electrical systems will improve workplace safety for the employees.

ELECTRICAL CODES

OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION. (OSHA)

OSHA is charged with enforcing federal rules and regulations covering work place safety. 29 CFR subpart S of the OSHA regulations addresses electrical safety requirements that are necessary for the practical safeguarding of employees in their workplaces. Subpart S is the federal law for electrical practices; it uses the NEC and API as a guide in its enforcement. One section of the OSHA regulations I reviewed dealt with deenergizing primary and secondary powerlines. The OSHA regulations is vague on its requirements, but it states that all circuits be DISCONNECTED[1] from all energy sources. This is interpreted by electric utilities to mean changing the powerline characteristics. I recommend that all powerlines scheduled to be deenergized have a phase to phase fault established on all three phases, and a phase to ground fault established. This will insure that a powerline is deenergized, improving safety over the common practice of cutting the jumper wires.

NATIONAL ELECTRIC CODE (NEC)

There are two national level electrical codes that apply to the oil industry: NEC, and the API-500B. The API-500B code refers to the NEC. The articles of the NEC that concern the oil industry deal with classifying hazardous areas, and specific grounding and wiring practices. NEC Articles 500 through 515 define what constitutes a hazardous area, classification, and specific electrical practices.

The NEC has three major divisions of hazardous (classified) locations (Table 1, Appendix A). The classifications are broken down further into divisions and groups. There is a division I and II for each class. The groupings will vary for the class and division. The NEC is the best source for a complete description of the classes, divisions, and groups. For onshore field environments, Class I, Div. and II are the major classifications.

AMERICAN PETROLEUM INSTITUTE (API)

The API RP-500B clarifies the NEC as it pertains to the oil industry. Basically, the API RP-500B follows the NEC hazardous location classification, and presents drawings of oil industry equipment and the appropriate hazardous classification. The publication also describes a detailed method of determining the hazardous classification of a specific area or piece of equipment. The API RP-500B does not present specific electrical practices. It refers all electrical practices (ie. wiring, grounding, conduit, etc.) to the NEC. The API RP-500B is to be used in conjunction with the NEC.

COMMON HAZARDOUS LOCATIONS

The setting in which the electrical work is being done is an onshore field environment. There are three main areas which have hazardous location classifications: waterflood injection buildings, main and satellite tank batteries, and wellheads.

Waterflood Injection Buildings

The interior of all injection buildings is classified as a hazardous location[2]. All areas below grade level (ie. sumps, cellars, etc.) on the inside of the building, are classified as a Class I, Div. I location[3]. The rest of the building is a Div. II area[4]. There are two methods for insuring compliance with the NEC on the type of lighting fixtures, conduit, and enclosures in an enclosed Div. II environment. The first is to make sure all the electrical devices are rated as EXPLOSIONPROOF and all conduit, sealing methods, and grounds meet Div. I standards. The second method is to provide sufficient ventilation to the building so that explosionproof fixtures and standards do not apply[5]. The control rooms of the injection buildings are considered a nonhazardous location if the control rooms have a separate ventilation source from the rest of the building. This ventilation source MUST provide a positive pressure inside the control room[6]. All conduit runs going from a hazardous location to a nonhazardous location must be sealed and there may be no union, coupling, box, or fitting in the conduit between the seal fitting and the point at which the conduit leaves the Div. II location[7].

Main and Satellite Tank Batteries

Tank batteries[8] and test/separation vessels[9] are classified as a hazardous location. A Div. II hazardous condition exists for all storage tanks and test/separation vessels for a radius of 10 ft (App. A, fig. 1). If there is a vent or gauge hatch, then a Class I, Div. I condition is present for a radius of 6 ft. from the outside diameter (O.D.) of the vent. When there is a dike surrounding the tank or tank battery, then everything below grade level of the top of the dike is a Div. II location. The exception is when ditching or excavating inside a dike encircling a tank or tank battery, then a Div. I condition is present inside the ditch or excavation.

All electric motors, conduits, control panels, switches, pressure, temperature, and level control devices MUST be rated for use in a hazardous location. This equipment must be rated for use in a Class I, Div. I environment or be NONINCENDIVE in a Group C or D atmosphere[10].

Lease Automatic Custody Transfer (LACT) Units are classified as a Div. II area for a radius of 5 ft. from the sample container[11]. Other parts of the LACT will be classified depending upon the specific device.

Wellhead Locations

All flowing wells and artificially lifted wells that are not enclosed by a building and do not have a cellar or sump, are classified as a Div. II location for a radius of 5 ft. from the stuffing box or pressure gauge valve[12](App. A, fig. 2). In the case of the artificially lifted wells, the Div. II area extends for a 10 ft. radius by 18 in. height distance from the inside diameter (I.D.)

of the tubing. All sumps or cellars of flowing or pumping wells are a Div. I area. The wells with sumps or cellars have a larger Div. II area on the surface. This Div. II area covers an 18 in. height by 10 ft. distance from the I.D. of the sump or cellar (App. A, fig. 3).

ELECTRICAL CODE REQUIREMENTS

The following paragraphs are not intended as a sole source of reference. They are intended as a reference for common oil field electrical practices. The NEC-1990 HANDBOOK is the definitive standard for electricians nation wide. If a question arises about an electrical procedure, the handbook should be used to settle the issue.

OSHA

CONTROL ROOMS

OSHA states in 29 CFR subpart S that insulating mats must be placed where live parts of motors or controllers, operating at over 150V to ground, are present. This subpart also sets the working clearance dimensions for electrical equipment in control rooms. All control panels and safety switches should be grounded. If this equipment is located on a panel rack, then each individual device needs to be separately grounded. All back plates of control panels and safety switches should have a bonding wire attached that leads to a separate ground. All raceways will be covered. Where Programmable Logic Controllers(PLC) are used there should be a separate ground for this device. Where an electrical device that frequently starts and stops is operating, it is recommended that a vacuum contactor be used.

NEC

MOTOR PROTECTION

On the inside of control panels that operate electric motors greater than 1 hp., the control transformer should be fused on the primary and secondary side. The motor over load relay WILL be fused[13]. There SHALL be a fuse inserted in each ungrounded conductor and also in the grounded conductor if the supply system is 3-wire, 3 phase AC with one conductor grounded[14]. These fuses WILL be sized for the running amperage of the electric motor. The contactor or starter WILL be correctly sized for the motor horsepower and amperage. The heater coils inside the starter WILL be sized for the motor horsepower and amperage.

Over sized fuses, starters, and heater coils are chief causes of burned out motors. This equipment is the last defense an electric motor has against a power surge or a single phase condition. When it is incorrectly sized for a specific motor, then that motor will eventually be destroyed.

CONDUIT

The NEC handbook lists six different types of conduits, and two types of tubing.

Rigid Metallic Conduit (RMC) & Intermediate Metallic Conduit (IMC)

RMC and IMC can be used in all atmospheric conditions[15]. In a hazardous location, either Class I, Div.I or II, there SHALL NOT be any union, coupling, box, or fitting in the RMC or IMC between the seal fitting and the point where the conduit leaves the hazardous location[16]. Therefore, all conduit in the tank batteries and below the dikes must be buried at least 6 inches[17]. This places the RMC or IMC in a nonhazardous location.

Rigid Nonmetallic Conduit (RNC)

RNC is NOT permitted in hazardous (classified) locations[18].

Flexible Metal Conduit (FMC)

FMC is NOT permitted to be buried, or used in any location where oil, gasoline, or other material having a deteriorating effect on rubber is present[19]. FMC is NOT permitted in lengths greater than 6 ft.[20]. FMC is permitted to be used as a ground under certain conditions[21].

Liquidtight Flexible Metal Conduit (LFMC)

LFMC is permitted for use in Class I, Div. II locations[22]. It can be buried, but NOT less than 24 in.[23]. LFMC MAY NOT be used in any location where it is subject to physical damage or high ambient or operating temperatures[24]. LFMC is NOT allowed to have lengths greater than 6 ft.[25] and it can be used as a ground if it's in accord with NEC article 250-79.

Liquidtight Flexible Nonmetallic Conduit (LFNC)

LFNC is NOT permitted in lengths exceeding 6 ft., where it is subjected to physical damage, high ambient or operating temperatures, or where the voltage of the contained conductors is in excess of 600V's, nominal[26]. LFNC can be buried, but NOT less than 24 inches[27] and it MUST be grounded separately if needed and in accordance with NEC article 250-79.

Flexible Metallic Tubing (FMT)

FMT shall NOT be permitted in a hazardous (classified) location[28].

Electrical Metallic Tubing (EMT)

EMT is NOT permitted in a hazardous (classified) location[29].

Corrosion protection MUST be given to all metallic conduits or tubing when buried. When the conduit is exposed to sulfur, whether buried or above ground, corrosion protection measures must be taken.

CONCLUSIONS

* Require that all electrical work meet OSHA, NEC and API standards.
* Field operating expenses will be reduced by upgrading the electrical system.
* Production will increase by reducing the down time caused by electrical problems.
* All deenergized powerlines should have a phase-phase fault and a phase-ground fault.
* Correct fuse sizing and properly wired control panels are critical to preventing damage to electrical equipment.
* Fused cutouts with attached lightning arrestors are an alternative to relocating powerlines.
* Improve employee workplace safety.

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Table 1
Hazardous Classifications

CLASS I	VAPOR-GAS PROOF
CLASS II	DUST PROOF
CLASS III	FLYINGS-FIBER PROOF

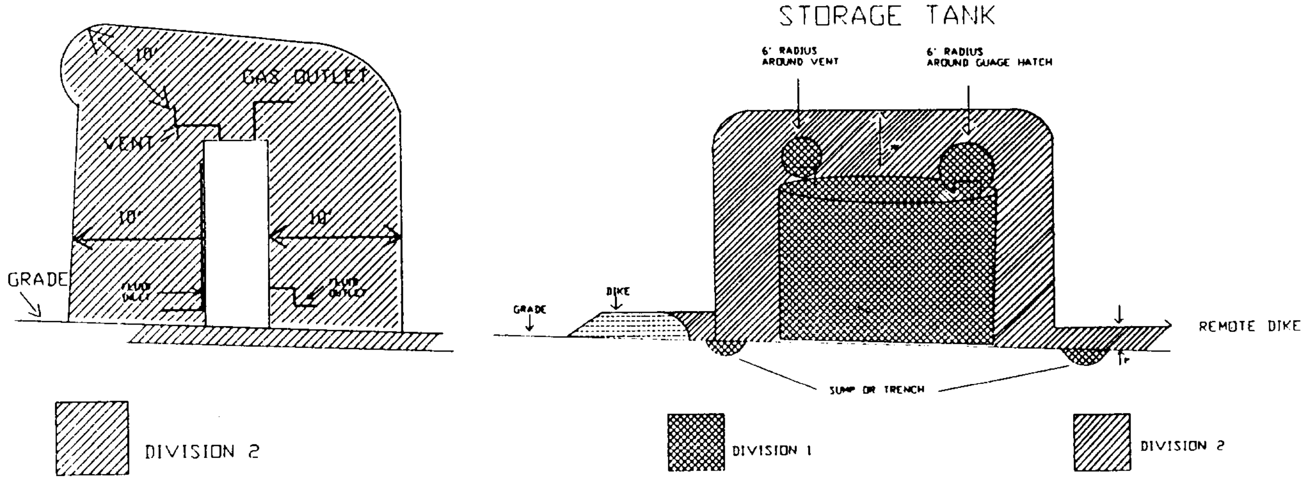

Figure 1 - API RP-500B & NEC classifications for tanks & vessels

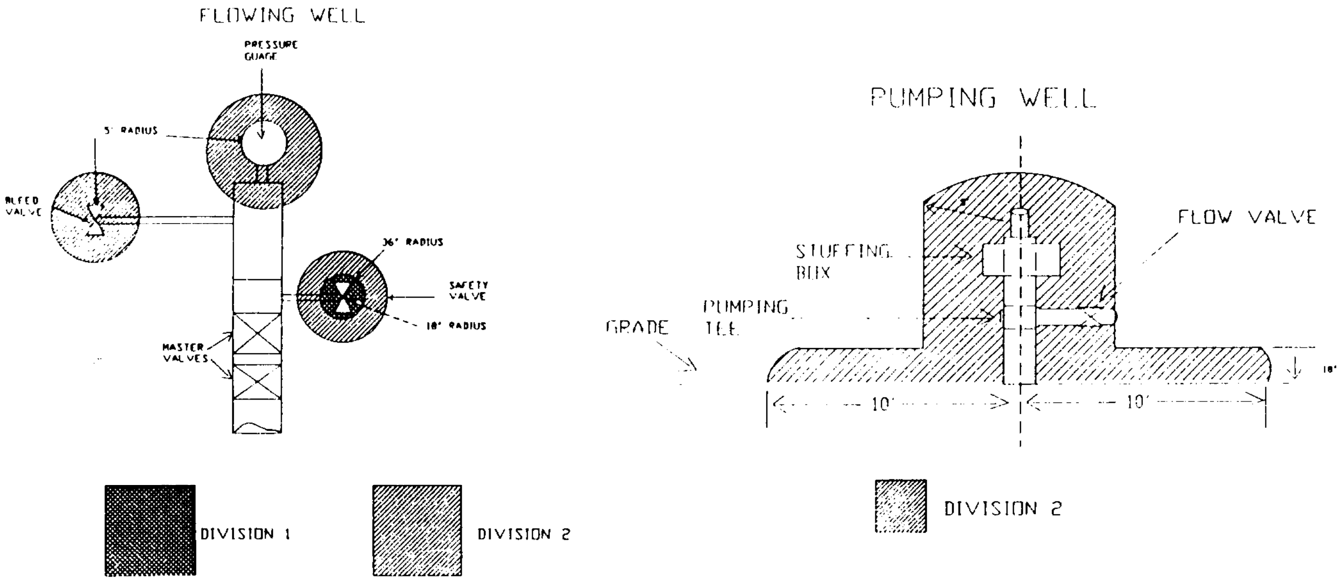

Figure 2 - API RP-500B, classified areas

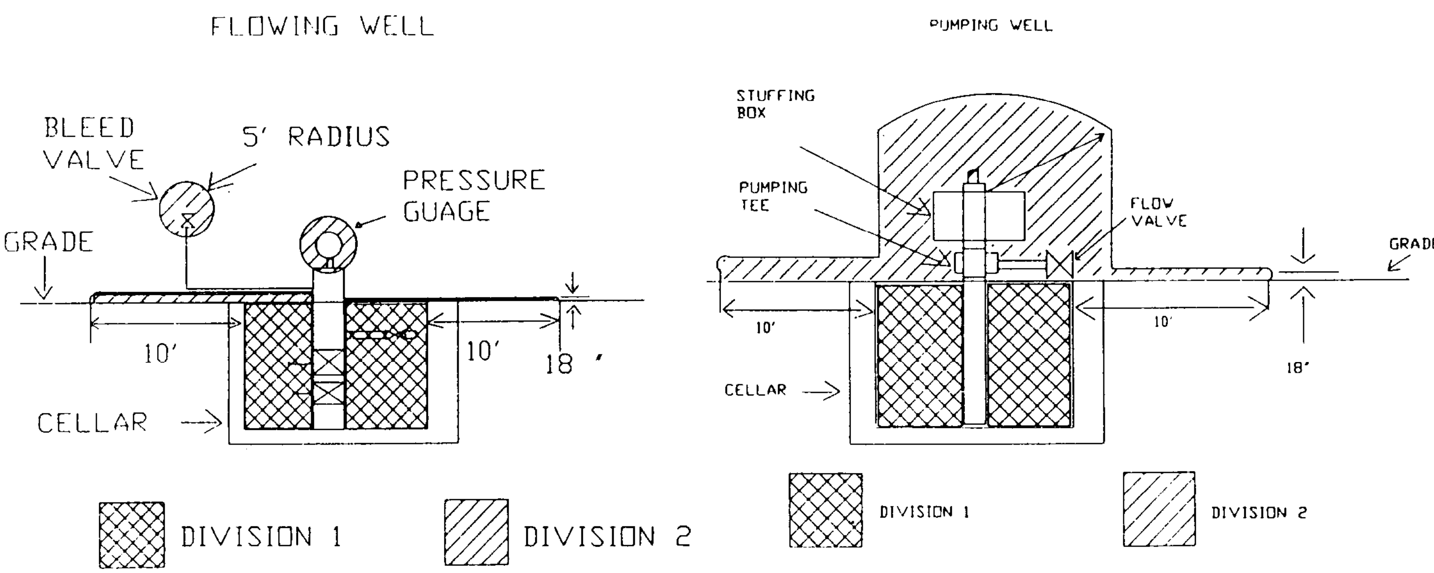

Figure 3 - API RP-500B, classified areas