

COMPENDIUM OF SUBJECT MATTER REFERENCES RELATING TO ABANDONED OIL WELLS

DOCUMENTS INCLUDE, BUT ARE NOT LIMITED TO:

- SITE ASSESSMENTS;
- OPA-1990 WORK PLANS FOR PROJECTS OVER \$50,000;
- SUB-CONTRACTOR BIDDING SHEETS FOR EQUIPMENT/PERSONNEL;
- DECONSTRUCTION, DRILLING AND PLUGGING PROCEDURES;
- FIGURES OF OIL WELL CONSTRUCTION, DOWN-HOLE EQUIPMENT, GEOPHYSICAL LOGGING TOOLS, GEOPHYSICAL LOGGING HEADERS, CEMENT BOND LOG SIGNATURES, SHOOTING AND PERFORATING WELLS, AND CAST-IRON BRIDGE PLUGS;
- APPENDICES ON WORK-OVER RIGS, NIOSH INSPECTION FORMS, MSDS SHEETS, TENORM REQUIREMENTS, CLASSES OF API CEMENT, AND CEMENT CALCULATION TABLES; AND
- OSHA REQUIREMENTS, PRESSURE CONSIDERATIONS, SAMPLE PLUGGING PLAN FOR A DEEP WELL, AND ASSOCIATED PLUGGING AFFIDAVIT;

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EPA-Region 4

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Abandoned Oil Well Plugging

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INTRODUCTION:

This document attempts to memorialize the Author's acquired experience relating to the re-entering and the proper plugging of abandoned and/or improperly sealed oil wells in the Southeastern United States. The writer's experience has spanned nearly 38 years in the field, while serving both the private industry and the Federal Government (EPA-Region 4).

Conservatively, he has either overseen and directed the permanent plugging in excess of over 2,000 leaking/discharging oil wells over his career. Most recently, he has successfully remediated and closed over 400 oil wells in Ohio County, Kentucky. This experience makes the author infinitely qualified and anxious to pass on some of the "Tricks of the Trade" when it involves problematic oil wells.

As such, he is earnestly compiling this report to impart the "Tried and True" methodologies and problem solving approaches that future geologists and field responders will surely face. Certainly when these same individuals are encountering similar discharging oil well conditions in their respective areas of responsibility, the forthcoming procedures can and will work in any oil field in the United States, irrespective of particular State or County.

The forthcoming methodologies are presented in generalized concepts in order for the reader to approach each individual well (and associated difficulties) with enough flexibility to identify alternative approaches as it applies to problem solving. Nothing presented, with respect to procedures, should be construed as "Set in Stone," but rather as proven and reliable alternatives which may be considered in the field. Regardless, no two wells will be the same.

DOCUMENT OUTLINE:

This document is divided into six (6) principle sections namely:

1. Initial Site Assessment (Deep Well Example); **(16 Pages plus USFW Report -Pages Not Counted);**
2. Sample (DRAFT) OPA 1990 Removal Action Plan and the Cost Estimates and Proposal Spreadsheets for Drilling and Plugging Sub-Contractor; **(16 Pages);**
3. Shallow Well (Extremely Low to Zero Reservoir Pressure) Methodologies; **(31 Pages);**
4. Figures **(31 Pages);**
5. Reading and Reference Appendices; **(291 Pages);** and

DOCUMENT OUTLINE: (Continued)

6. Deep Well (and/or Dangerous and High Pressure) Precautions and Methodologies; (98 Pages).

A summary for each of the aforementioned divisions is as follows. They can be referenced singly, in parts, or in their entirety. It's completely up to the individual reader to decide what level of information he or she requires.

Section One: (Well Site Investigation and Assessment) provides a comprehensive real-world example of an ABANDONED DEEP WELL LOCATION in Carthage, Mississippi. It was referred to EPA-Region 4 by the USFWS via the National Response Center (NRC). This evaluation report is broken out into seven (7) sections relating to this discharging oil well (a.k.a. Armstrong Union Oil 3). The contents are as follows: Introduction; Well (Site) Information, Background; Objective and Scope; Findings; Conclusions and Recommendations; and Appendices. This document provides an excellent example of a typical field assessment and summary for the responder to use as a template.

Section Two: (DRAFT-OPA 1990 Removal Action Plan and a Cost Estimate/Proposal for Drilling and Plugging Sub-Contractor) provides a six (6) page OPA 90 Work Plan which the USCG National Pollution Fund Center (NPFC) requires from the EPA On-Scene Coordinators (OSCs) for all OPA 90 funding driven removals in excess of \$50,000. The reader is encouraged to pay special attention to the legal citations and the eight (8) threat criteria cited in the document. Both the legal and threat conditions will likely be found at all orphan oil well sites. This document can be found in Supplement 2-A.

Supplement 2-B provides two examples consisting of a (SAMPLE) blank spread sheet and a (SAMPLE) filled-out response derived from a drilling sub-contractor. The former document allows the Government to formulate the associated costs and expenses (on a daily basis) which should be utilized for deriving an Independent Government Cost Estimate (IGCE). IT DOES NOT CONTAIN ALL OF THE NECESSARY EQUIPMENT AND SUPPLIES TO BE USED, BUT IT CAN BE USED AS A GOOD REFERENCE SHEET FOR DERIVING SIMILAR SPREAD SHEETS ON VIRTUALLY ANY PLUGGING JOB. Most oil field work-over companies can and/or will provide their established rates when contacted directly. Sometimes, these same companies will publish their daily rates on their company web pages.

The spread sheet can also be provided by the Government to the Prime Contractor for obtaining bids from the prospective bidders. Costs are certainly of grave consideration when selecting the appropriate oil well work-over company (OWWC). However, qualifications, experience, safety record, and reliability are much more important when choosing the most qualified OWWC and/or supporting personnel.

DOCUMENT OUTLINE: (CONTINUED)

It's important to note that the spread sheet includes line items for the geophysical logging firm (GLF). This is important because the prime contractor will need to identify and hire a GLF in advance of starting the job. This assures that close coordination is established between all parties, and all associated down-hole logging equipment, explosives and bridge plugs are available on a moment's notice. It also captures the expected costs.

Section Three (Shallow and/or Low Pressure Oil Wells) provides a "Cook Book Approach," as it pertains to: deconstruction of an oil well; downhole geophysical logging techniques using suites to evaluate well construction; oil field explosives types and methodologies (as it pertains to cutting and perforating techniques); placement of cast-iron bridge plugs; cement squeezing protocols; and cement plugging placement methods. These instructions are intended for open wells with EXTREMELY low residual oil reservoir pressures that **do not pose a substantial threat of fires and explosions**. This is the reason that hydrostatic columns of fresh water are continuously utilized to control down hole pressures. All wells can be plugged according to these methods.

Should the well (s) develop ANY SUBSTANTIAL pressures while plugging actions are ongoing, one must immediately stop plugging activities and shift all field operations to include a blow-out preventer, mud pumps, drilling mud and so forth. The reader would then transition to operations as specified in Appendix 12, which is found in Section Six of this document. All work from here on out must be performed under the full-time direction of a highly qualified and experienced petroleum engineer. Without this direction, onsite personnel are in danger.

Section Four: (Figures) includes nine (9) very useful schematics as it pertains to: scraping equipment and swages; a cross section of an oil well and its component parts; oil well production (sucker) rod deconstruction; a drawing of a down-hole geophysical log consisting of three types of sensors; a sample cross section of a well with an emphasis on the methodology on how to plug the well when the tubing is stuck in the well; a sample of a geophysical logging header; the six typical cement bond log interpretation models (i.e. as they pertain to plugging strategies); and a pictorial of a cast-iron bridge plug. All provide the reader with a basic visual representation of the production equipment, drilling tools, and data representations associated with plugging an oil well.

Section Five (Appendices) consists of twelve (12) key references and articles appertaining to: Gin pole and/or Work-Over Rig Operational Guidelines; the OSHA Guidelines for the Proper Setting of Guywire anchoring systems; the NIOSH RIG CHECK Inspection Forms for Small Companies Whose Safety and Health Resources are Limited; the Material Safety Data Sheets

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(MSDS) for Crude Oil, the MSDS for Hydrogen Sulfide, and the MSDS for TENORM Impacted Equipment; the Source Compendium for the Management and Disposal Alternatives for TENORM wastes; the American Petroleum Institute (API) Classes of Cement (with recommendations on densities and weights); the Standardized Haliburton Cementing Tables; and a very rudimentary introduction to geophysical well logging. The reader should consider these as a beginner's library of expanded information which will aid him/her a in further understanding of the plugging materials needed, the vital drilling/workover equipment to be utilized, the underlying health and safety concerns; and so forth when plugging and abandoning a leaking oil well. While the reader may have prior experience in this area of field response, the intention is to provide a base-line compendium for future reference. The Author encourages others to add to these Appendices in the future, so that those who come behind us can continue to learn from one other's experiences.

Section Six (Cover Memorandum and Appendices 12 through 16 for Deep/High Pressure Wells) consists of five (5) key references and articles relating to the following subjects :

- Appendix 12- the American Petroleum Institute Paper 54-Occupational Safety and Health Practices for Oil and Gas Operations;
- Appendix 13- Considerations for High Pressure Well Control;
- Appendix 14- the copy of the Armstrong Union Number 3 Well, as Drilled and Constructed on July 15, 1971 In Carthage, Mississippi and Plugging Affidavit in October 1972;
- Appendix 15- a Sample (Simplified) Work Plan written by a Professional Petroleum Engineer with input by the Author for the re-plugging of the Armstrong Union Number 3 Well; and
- Appendix 16-Callon Petroleum Re-Plugging Report for the Armstrong-Union Number 3 Well dated November 4, 2020.

SPECIAL CAUTIONARY NOTE AND WARNING:

The reader must ALWAYS assure that a highly qualified and experienced petroleum engineer be placed in charge of all field operations when high reservoir pressures are suspected and/or encountered. This is especially important with regards to safety, prescription of drilling mud weights, selection of blow-out protectors, and properly weighted cement. Without this expertise, the likelihood for accidental fire and explosion is EXTREMELY HIGH!! One CAN NEVER go it alone without this expert.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION 4- ERRPPB

MEMORANDUM:

FROM: Charles K. Eger, Professional Geologist

TO: File

SUBJECT: Differences in Plugging and Safety Protocols for Oil Wells With and Without Reservoir Pressures

DATE: 29-January-2021

The reader who closely reviews this compendium in its entirety (i.e. Sections One through Six) will deduce immediately that the Author has provided minimal written protocol relating to the re-entering and plugging of deep (a.k.a. medium to high potential for oil reservoir pressure) wells. **This is no accident!** All of the associated well operations will ALWAYS require the full-time monitoring, supervision, and direction from a very seasoned petroleum engineer who has extensive knowledge of the specific oil field being remediated. Failure to adhere to this stipulation, will result in a catastrophic fire or explosion.

This cautionary recommendation is based on very extensive discussions involving two extremely seasoned petroleum engineers with over 70 years combined field experience and the Author who has amassed 37 years of knowledge relating to oil well plugging in four southeastern States. Section Six contains five (5) invaluable references and examples of issues, equipment, safety, and protocols relating to plugging deep and/or medium to high pressures wells. Appendices 12, 13, and 15 provide key references when a field responder is contemplating the plugging and/or re-plugging of the aforementioned wells.

If there is any possibility of oil and gas reservoir pressures associated with the well(s) in question, a highly experienced petroleum engineer must prescribe all equipment and safety procedures associated with all field operations and direct said actions. Potential required equipment shall include, but will be limited to:

- Workover Rig,
- Double Stack Blow-out preventers with pipe rams and blind rams installed,
- Rig-up Mat for ground support as workover rig support,

- Two Workover tanks (1 for drilling mud and 1 for fresh water),
- Approximately 250 bbls (i.e. 42 gallons per bbl) of drilling mud mixed at a minimum of 9.6 lbs/gallon,
- Triplex mud pump,
- 70 bbl Vacuum truck with pump,
- Roustabout crew labor for equipment setup and removal and site cleanup,
- Power Swivel- (approximately 85 tons of torque or more),
- Washout head and Replacement rubbers,
- Two pipe skids for rental tubing string,
- Truck and float for hauling tubing and plugging equipment,
- Bulldozer for building road to the well site,
- Rental string of 2 7/8", 8rd EUE J-55 tubing (equal to total depth of the well,
- Rental 3 1/2 " drill collars and crossovers,
- Rental drill bits and scraper,
- Welder to cut off top of any bent casing and weld a bell nipple on it,
- Bell Nipple,
- Casing head with 2- 12" XS A/SA Grade B Carbon Steel seamless pipe nipples and 2- 2,000 pound ball valves,
- Swedge which tapers to a 2"-3" nipple that will screw into surface casing (for bullhead squeeze),
- Rhino UTV(s), and
- Command and Control trailer.

This list is not intended to be all-inclusive. It will aid the field responder, On-Scene Coordinator, and/or the Petroleum Engineer (PE) when scoping out deep well projects. One should NEVER blindly template off of this list without complete coordination with a PE.

Sections 3, 4, and 5 of this document provide a very detailed cookbook approach in sequential order for plugging a shallow-low pressure oil well. This is the simplest type of approach for permanently plugging a leaking oil well.

Plugging procedures for shallow and deep wells are nearly identical with the great exceptions associated the effective control of residual reservoir pressures **(as prescribed in Paragraph 3 of this document)**. In more simple terms, both types of wells will require identical steps as it pertains to the following:

- well dismantling,
- tubing and pumping rod and removal,
- drilling and scraping the inside of the production casing from surface to total depth,

- geophysical evaluation of the well casing and quality of cement behind the production casing,
- setting of a cast-iron bridge plug to protect cement integrity during hardening,
- perforation of production casing where the cement in the annulus is insufficient to preclude the migration of fluids,
- circulating of cement from total depth to land surface, and
- squeezing of cement (via bullhead squeeze) on the back side of the production casing from total depth to land surface.

This sequential and comprehensive plugging approach has been consistently utilized on many hundreds of wells in the Southeastern U.S. When strictly used, the above methods assure unprecedented successes with respect to the effective plugging and abandonment of previously discharging oil wells. The Author has never had an occasion to re-drill out a well plugged under his direction. These methods, in the opinion of the Author, are the only reliable standard to consistently use in the field. Anyone who willfully chooses to deviate from these procedures will most likely encounter wells that will continue to leak long after the plugging methods are attempted. Should this happen, the well will require milling out the cement plugs back to the total depth of the well and re-plugged. This is a very expensive endeavor which can be avoided if the reader follows the protocol as prescribed in Sections 3 and 6.