SPE 29746

Estimating and Reducing Company Wide Property Abandonment Costs

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Abstract
Many domestic oil and gas properties and production facilities are at the end, or rapidly approaching the end, of their useful economic lives. Corporate management is becoming increasingly concerned with the costs associated with the abandonment of these properties and their potential impact in long range planning scenarios and property evaluations. Abandonment and environmental remediation costs are generally expected to rise in the future due to increased regulation and more rigorous clean-up standards. Identifying these costs and raising management's awareness of these costs in today's operations will help management plan for this approaching problem and generate ways to reduce those costs.

The paper describes the steps necessary to organize and manage a successful abandonment and remediation cost study of company wide magnitude. Areas discussed include organization of the review teams, field data gathering, determination and application of historical cost data, and actual cost estimation. The paper presents typical results of the study for various types of production fields facilities as well as ideas for actions today to reduce future abandonment and remediation costs.

Introduction
A major domestic producing and exploration company recently conducted a comprehensive study to estimate property abandonment costs and to identify changes in current operating practices that could potentially reduce future abandonment liabilities. The study estimated facility demolition, well abandonment and environmental clean-up costs, in current dollars, for all "lower 48" onshore producing properties. In arriving at estimated costs, we assumed the return of all production sites to a condition suitable for other expected surface uses. Individual property assessments also identified any unusual abandonment conditions that could economically impact the property's value to the company.

Costs associated with the abandonment of wells, demolition of facilities and environmental cleanup of soils are becoming a significant factor in property planning and evaluation. New regulations, stricter abandonment rules, soil remediation requirements and increased regulatory oversight as well as increased public awareness and involvement, have collectively increased the cost of lease abandonment.

Property restoration costs have increased dramatically in recent years. The historical assumption that the cost to abandon a producing lease and the associated facilities will be covered by the scrap value of the equipment is no longer true. In the past, companies specializing in the abandonment of wells accepted recovered casing as payment for their services and demolition firms removed tanks, separators and piping for the metal scrap value. Today, in most areas, well and facility abandonment firms must seek payment in addition to scrap value.

Surface owners now often require mineral lease owners to remediate impacted areas. Soil remediation, revegetation and land contouring is now an integral part of the abandonment process.

Although cost estimates of well abandonments, facility demolition and environmental remediation had been done separately in a number of locations, each of these studies used different cost assumptions, clean-up criteria and assessment techniques. The cost estimates were not comparable or suitable for summation to estimate total property remediation costs.

Key Factors for Success
The key factors for success of the study included: 1.) management commitment, 2.) development of consistent cost estimates, 3.) access to all facilities and key personnel and 4.) acceptance of the process by legal, accounting, tax, operations, environmental and engineering groups. Each of these factors had to be resolved before the study could be started and successfully completed.

Management quickly identified the need for a study to examine rising abandonment costs and assess the uncertainty about future costs. A senior level person was designated to

References and illustrations at end of paper coordinate a task force to address these issues and to identify processes to reduce future potential environmental liabilities.

Consistent estimation of the abandonment and remediation costs was the critical element to the success and integrity of the study. On-site assessments of each production facility (gas plants, tank farms, test stations, oil, gas, injection and disposal wells) were conducted by a small group using identical checklists and guidelines to achieve uniform cost estimates. Abandonment and remediation costs were estimated from visible or known conditions only. Where available, past records were reviewed to determine historical well abandonment, facility demolition and environmental remediation costs for a particular area. Database and statistical estimation techniques were applied to the data gathered to generate the final estimates.

Management and the task force members communicated to the field operations personnel the importance of the study. The purpose of the study had to be properly communicated to the operations personnel. The study team members needed to know about specific field operations and practices so that credible cost estimates could be made. It was imperative that the site reviewers work very closely and gain the trust of the field personnel for the study to be successful.

Key members from different legal, accounting, tax, operations, environmental and engineering groups were assigned to the project to assure that the results of the project would also meet the needs of each of these groups. The data and results had to be gathered and presented in a way which would be meaningful to each of these diverse groups.

Organization of the Work Teams

The study required the formation of two work teams to determine the scope and set the goals, plan the site visits, gather and analyze the data and present the results to management. One of the teams was the management oriented "steering committee"; the other was the "review team" which would implement the study.

The "steering committee" consisted of legal, accounting, tax, operations, environmental and engineering representatives from throughout the corporation. With input from legal, this committee developed the goals, scope, and methodology of the study, agreed on those cleanup standards which would form one of the assumptions of the study and nominated personnel to serve on the "review team." It was critical to the success of this project for each team member to contribute their key issues and for the entire team to agree on the treatment of those issues.

The "review team" was set up to plan the site visits, gather and analyze the data and develop a meaningful presentation of the results. This team consisted of environmental, engineering and operations personnel from different locations in the company.

Goals

The goals of the study were twofold: 1.) to determine the potential cost of abandoning and remediating properties and 2.) to identify opportunities to reduce future abandonment costs. The study was intended to provide a reasonable estimate of the costs involved to return the sites to a condition suitable for other expected surface uses. The individual property assessments also identified any unusual abandonment economic conditions.

Scope

All company operated onshore properties and properties which the company had a working interest in, but were "Operated by Others" (OBO) were examined during the study.

The study is classified as a "Level 1" or historical study. Information and data were gathered primarily from site visits, interviews with operations personnel and file documents.

The cost estimates are intended to be reasonable estimates of expected remediation, abandonment and demolition expenses based on current site conditions, regulations and past experience. Costs were estimated from visible or known conditions only. Actual environmental remediation costs could increase as additional requirements are identified through continued testing, soil borings, excavations, etc. Similar increases may occur when abandoning wells or when demolishing facilities.

Costs associated with future or proposed operations, proposed regulation changes or the cleanup of presently undefined conditions were not considered in this study.

Methodology

The methodology of the study is outlined below.

A.) Meetings with Operations groups to explain the goals of the study, review the data requirements, site review procedures and discuss any implications for their operations.

B.) Preliminary data gathering for each property, including property location, number of wells (producers, injectors, disposal wells and idle wells), location of tank batteries and other facilities (compressors, gas treating equipment, etc.), plot plans, SPCC plans, pipeline routes, maps and any other related information to help identify property parameters.

C.) Current state and federal regulation reviews for each area to determine preliminary well abandonment, facility abandonment and site remediation requirements.

D.) On-site data gathering as needed to fully determine abandonment and remediation costs. On-site information gathering activities included:

- Interviews with lease and/or facility personnel concerning current practices.
- Gathering of information about historical lease operations, potential abandonment problems, local rules and regulations and other items which may aid in the proper determination of abandonment and remediation costs.
- Well, battery, and facility inspections to determine potential abandonment problems or unusual items. Existing pipe yards, buildings, dumps, pits, underground tanks etc. were also inspected to help estimate remediation costs.

•Inquiries about neighboring facilities to determine if any off-site activities could have contaminated the company's property.
•Completion of three different field data sheets developed specifically for this study.

E.) Determine well abandonment, facility demolition, and environmental restoration costs from gathered data.

F.) Review data and compile final report.

Gathering Field Data

The successful completion of the study required extraordinary planning. The task force was faced with having to estimate the abandonment costs for over 8700 wells and associated facilities located on approximately 1280 properties in eight different states within a six month, management requested time-frame.

To manage this task, properties to be reviewed were divided into three geographic areas. A field review coordinator was assigned to gather the required data in each area. Local personnel assisted with the data gathering. Figure 1 shows the form which was used to record field data. The data was then either entered locally or at the central office into a cost estimating program (Figure 2) where the final cost estimates were made by the coordinator.

Estimating Well Data for Large Fields

Many of the properties reviewed had 50 or more wells. Visiting each of the wells and reviewing each individual well file to determine abandonment and remediation costs was not feasible in the given time-frame. Statistical sampling and estimation techniques using high confidence limit factors were employed to obtain the data needed. Factors statistically estimated included well depths for well abandonment cost purposes, estimates of soil volumes around well heads and the size of well pads which would have to be reclaimed for large fields.

A representative sample of each field was taken to achieve a 90% confidence level in the final estimates. Guidelines were adopted using the principles described by Arthur D. Little Inc.[1] to assist in determining the proper sample size. Figure 3 shows an example spreadsheet calculation to determine the upper and lower limit of the 90% confidence limit of the true mean.[2] The value representative of the 90% upper confidence limit of the true mean was used in the cost estimate calculation.

Treatment of Co-Owner Operated Properties

Co-owner operated properties represent over twenty percent of the properties included in the study. The steering committee decided that these properties must be included in the study if an accurate composite figure was to be developed.

Obtaining information about properties which were operated by others presented several problems. Contact with joint interest properties is normally carried out between the operations, engineering or land groups of the operating company and with the joint interest operations group of the working interest owner. Day-to-day field operations practices and operating characteristics of these properties are normally outside the scope of responsibilities for these groups. It was apparent that field visits to each co-owner operated property would not be feasible.

An alternative means of gathering information had to be developed for this study. A questionnaire covering each of the co-owner operated properties was sent to the operator. This questionnaire (see Figure 4) focused on gathering information about the highest cost parameters in the study. These questionnaires were followed up on to insure that they were returned in a timely manner. It became apparent that the questionnaire would not generate all of the information necessary and that another follow up method would be necessary. It was decided to estimate costs for the remaining properties based on the type of operation, location and number of wells.

To assure the accuracy of the estimates, an on-site visit was performed on 80% of the co-owner operated properties. In these on-site visits to the different fields an attempt was made to review the operations of most co-owner operators and the different type of operations that existed in each field. These visits were performed on leases that were easily accessible, so that a two person team could in a timely manner determine the factors needed for the cost estimates. After reviewing each of these fields, the reviewers were able to determine the size of locations, tank battery sites, equipment, use of surrounding land, type of operation and other factors required to estimate costs.

Data from the questionnaires, field reviews, and assumptions were entered into a cost estimating spreadsheet program. The unit cost estimates were derived from cost estimate data formulated from Company operated properties. The data was summed for each area and compiled for the final report.

Estimation of Costs

The three major categories of expenses considered for this study were environmental remediation, well abandonment and facility demolition. Each category and its associated costs are discussed below.

1. Environmental Remediation

This category primarily covers the removal, disposal or remediation of contaminated or hazardous materials.

Contaminated soil cleanup is generally the major component of this cost category. These costs include the clean-up of oily soils around wellheads, pipeline spills, tank batteries and underneath tanks as well as the remediation of salt-contaminated areas.

Costs for disposal of materials such as NORM, PCBs, asbestos, mercury-contaminated soils, or chemicals are included in this category.

This category also included any miscellaneous costs particular to that environmental setting identified by the site reviewer, such as trash dump cleanup.

Costs for remediating and restoring the properties were based on several sources, including contractor price sheets, recent experience, and operations personnel's experience where unusual costs were expected. The cost to excavate, back-fill and remediate the contaminated soil was determined by estimating labor, equipment rental, trucking and remediation costs based on contractor price sheets.

Hazardous waste disposal costs were included if the item had a potential to be a hazardous waste at the end of its useful life.

2. Well Abandonment

Well abandonment costs include both the downhole and surface costs to abandon wells based on the current rules and regulations. The downhole portion of these costs typically include the cost of removing the existing completion assembly, setting cement plugs, removing the casing and cutting the well off below ground level. Surface costs generally include removal and revegetation of the well pad and other items associated directly with the well.

Past well abandonment costs were examined in each area to determine model parameters. Generally, the cost of abandonment could be correlated directly to well depth below 5000'. Abandonment costs for wells less than 5000' could not be correlated to depth and a minimum abandonment cost was used. Figure 5 shows a plot of historic abandonment costs versus depth for a single geographic area. The graph indicates $2.00 per foot of depth with a minimum cost of $5000 for this particular area. A similar graph was developed and used to determine abandonment costs for each geographic area.

3. Facility Abandonment

Facility abandonment costs include the costs of removing pipes, tanks, vessels, processing equipment, buildings, concrete bases, etc. The estimate assumed that all equipment, piping, etc. would be removed and sold for scrap, not reused elsewhere.

Facility demolition estimates are summations of the costs for removing the individual pieces of equipment at each site. Individual equipment demolition costs were based on contractor price sheets to include labor, equipment rental and trucking costs and demolition time estimates. Figure 6 shows how the costs were determined for the removal of several pieces of common oilfield equipment.

Facility demolition and soil remediation costs were checked against recent actual costs to test the estimation model. For example, the estimated costs to remove a tank farm was compared with actual invoiced costs. The actual and model estimated costs were within 10%. Similarly, actual demolition costs of a gas plant were compared with modeled costs. Again, the costs were within 10% of each other. Other cases, where actual invoiced cost data was available, were checked by the field review coordinators to confirm the validity of the model.

Cost Estimate Summary

The study determined that 61% of the estimated cost to remediate a property is the direct cost associated with abandoning the wells; environmental remediation costs account for 22%, and facility demolition accounts for the remaining 17%.

Costs were generally higher for oil producing properties than for gas producing properties. Oil producing properties were often burdened with costs associated with demolishing producing facilities and remediating oily soil. Gas properties typically had fewer associated facilities and very small volumes of soil requiring remediation.

"Best Practices" Summary

During the study, field operations personnel were interviewed to determine the "Best Practices" methods for dealing with abandonment and environmental remediation issues. Members of the review team found that each area had different ways of addressing these issues and that many areas had implemented new and innovative techniques to reduce environmental impacts.

Efforts have also been made to clean-up existing impacts to the environment and prevent or reduce future potential liabilities. Many individuals have taken the initiative to develop containment devices, workover equipment, waste handling equipment and soil remediation techniques to reduce environmental impacts. Collectively, these efforts provide a wealth of experience and techniques for dealing with these environmental issues. A few of these efforts are discussed in the following paragraphs.

Operations groups are continually looking for ways to improve the handing and disposal of oily waste. Better housekeeping in several areas has been very effective in improving lease appearance and reducing potential liabilities. Bulk storage facilities and secondary containment, such as drum coffins, have reduced chemical spills onto the ground. Many small oil leaks have been contained by installing drip pans and various types of devices for stuffing box leaks. Spills onto the ground from workover operations have been greatly reduced in many areas through the use of specially-designed catch basins and steel workover pits. Facilities for separating liquids and solids to ease disposal problems have been installed in several areas. Other areas have dedicated facilities to collect the waste until it can be treated.

Field operations groups are recognizing that abandoned concrete bases may represent a future cost. Several areas are developing creative disposal solutions by using the concrete for fill material when closing pits. Different techniques are being used in several areas to breakup large concrete bases so that they may be disposed of.

Field personnel are also taking the initiative and experimenting with many different methods to remediate soils. Bioremediation has been tested with varied success.

Methods to Reduce Potential Liabilities

The methods below were developed from the on-site reviews and discussions with operations and environmental personnel.

1. Improve Environmental Housekeeping

Environmental housekeeping standards should be implemented in areas to minimize future clean-up costs. The standards should be flexible to allow each area to meet the particular needs of their unique operation while reducing the future costs.

2. Strive to Reduce Soil Contamination

Operations should consider the following modifications to reduce or eliminate soil contamination.

A.) Install secondary containment around all chemical day tanks, drums, pumps, etc. Secondary containment has proven

cost effective in many areas. All facilities should be reviewed to determine where additional secondary containment devices could be installed to reduce or eliminate soil contamination.
B.) Eliminate leaks from stuffing boxes on sucker-rod pumped wells. There are inexpensive (<$100), simple devices on the market which may prevent leakage from reaching the ground.
C.) Surplus equipment, junked vessels and abandoned facilities should be removed from the lease in an appropriate manner. Often, idle transformers, tanks, vessels etc. may contain materials which could contaminate the soil as their mechanical integrity deteriorates over time.
3. Establish a Soil Remediation Program
Institute a program to effectively identify soil remediation techniques, train operations personnel in their use, and monitor the results of these efforts.
4. Implement a Risk-Based Well-Abandonment Plan
The status of idle wells should be reviewed, and a risk-based abandonment program developed.

The API has developed risk-based guidelines for determining if wells should be abandoned. These guidelines are in Bulletin E3 titled "Environmental Guidance Document: Well Abandonment and Inactive Well Practices for U.S. Exploration and Production Operations."[3] This document could be used as the basis for developing individual risk-based abandonment plans in the different operating areas.

Adopting a risk-based well abandonment plan consistent with various state regulations in areas could reduce the probability of contributing to groundwater contamination.
5. Install Dedicated Facilities for the Handling of B.S. and W. Waste

Facilities designed for the handling of B.S. and W. waste should be installed in areas where volumes are sufficient.

Several areas already have facilities in place. Concrete lined pits or steel tanks store the waste and allow separation time. Liquids are skimmed from the surface by a vacuum truck and the remaining dry, oily sand material can be used for road base or land-farmed legal requirements permitting.
6. Use Steel Workover Pits in High Risk Areas
Portable steel pits or tanks should be used in lieu of plastic lined earthen pits for workovers in high risk areas.

Operations personnel in most areas have found that the cost of using portable steel tanks is comparable to constructing an earthen pit.

Conclusions

Implementation of a company wide comprehensive study of this magnitude can be accomplished in a timely manner. Gaining management commitment, involving all impacted groups, securing access to all facilities and personnel and developing consistent cost estimates are the key factors in the successful accomplishment of this study.

The study found that while well abandonment costs comprise the majority (61%) of the costs required to abandon and restore a producing property, environmental remediation and facility demolition expenses are significant and account for over a third of the total lease abandonment costs.

The study has also identified many ways which can reduce future environmental clean-up costs. Better housekeeping standards, reducing soil contamination, remediating contaminated soil, using a risk-based well abandonment program and using steel pits to prevent soil contamination are all methods which may reduce or eliminate future environmental remediation costs.

Acknowledgments

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References

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2. Hays, W.L.: *Statistics,* Holt, Reinhart and Winston, New York City (1981) 176.
3. "Environmental Guidance Document: Well Abandonment and Inactive Well Practices for U.S. Exploration and Production Operations," American Petroleum Institute, Washington D.C. (1993).

PAAER
SOIL REMEDIATION AND HAZARDOUS MATERIALS FIELD COST ESTIMATE DATA SHEET

I. GENERAL INFORMATION

Field ____________ Property ____________
Reviewer: ____________ Date: ____________
County: ____________ State: ________ Dist. Contacts: ____________

	Ag.	Ind.	Res.	Undev.	Other (Explain)
Present Land Use:	[ ]	[ ]	[ ]	[ ]	[ ] ____________

Soil: [ ] Sand [ ] Clay [ ] Gravel Describe ____________
Other Site Information: ____________

II. WELLS

Wells: Producing: ________ Injection: ________ T/A ________ Other: ________

Well #	Type (P?, I?, O?)	Stain Area (Dia.)	Pad Size (L X W X D)	Comments (Pits, Pad Material, Roads etc.)

Well Abandonments:

Well #	Type	Plug Back Depth	Well #	Type	Plug Back Depth

III. FACILITIES

Item	Cent. Bat					
Amine Units (#)						
Building Foundation (sq ft)						
Buildings (L X D X H)						
Chemical Storage Areas (#)						
Compressors (hp)						
Concrete Bases (#)						
Dehydrators (MMSCFD)						
Electrical Panels (#)						
Fence (ft.)						
Flare Systems (#)						
FWKO's (#)						
Heater Treaters (#)						
LACT Units (#)						
Metering Systems (#)						
Misc. Vessels (#)						
Pad Size (acres)						
Piping (ft)						
Pumps w/ Motors (#)						
Tanks, Misc. (#)						
Tanks, Oil and Water (#)						
Transformers (#)						
Utility Poles: (#)						
VR Units (#)						
Other:						
Other:						
Other:						

Pipelines: [ ] On surface [ ] Buried===>Remove? [ ] Y [ ] N *If Yes, Please complete:*

Size	Length	Contents	Depth	Comments

Roads to be Removed
Miles ________ Width ________ Thickness ________ Material ________ Comments ____________

IV. ENVIRONMENTAL REMEDIATION COSTS

Stain Areas (Tanks, Tank Farms, Well Testers, Bermed Areas and Other Facilities):

Item	Size (L X W X D)	Sal. (1-5% or >5%)	Comments

Hazardous Materials

Item	Present (Y or No)	Description (Size, Quantity etc.)	Comments
Asbestos			
PCB's			
NORM			
Haz. Waste			
Underground Tks.			
Dumps			
Drums			
Other:			

Comments: ____

Photo Log: Roll ______ Frame 1. ______ 2. ______ 3. ______ 4. ______ 5. ______ 6. ______ 7. ______
8. ______ 9. ______ 10. ______ 11. ______ 12. ______ 13. ______ 14. ______ 15. ______ 16. ______
17. ______ 18. ______ 19. ______ 20. ______ 21. ______ 22. ______ 23. ______ 24. ______ 25. ______
26. ______ 27. ______ 28. ______ 29. ______ 30. ______ 31. ______ 32. ______ 33. ______ 34. ______
35. ______ 36. ______

Attach plot plans, schematics or other information to aid in estimating costs.

Fig. 1 - Field Data Sheet

Item	Input Data	Cost
Field	SPE Example	
Property	SPE Example	
Operator	Domestic Major	
WI	75.00%	
# Producing Wells	57	
# Injection Wells	15	
# Other Wells (TA etc.)	5	
***Environmental Remediation	Costs ***	
****Typical Prod. Well****		
Prod. Wellhd. Rmd. Dia. (ft.)	6	$26,847
Pit Area,sq-ft	0	$0
****Typical Inj. Well ****		
Inj. Wellhd Rmd. Dia (ft.)	3	$883
Pit Area,sq-ft	0	$0
****Typical Other Well****		
Other Wellhd Rmd. Dia (ft.)	6	$2,355
Pit Area,sq-ft	0	$0
**Stain Areas **		
Item:	Near Well 1-A	
Volume (cu-ft)	5000	
Saturation >5% (N=0,Y=1)	0	$2,222
Item:	Pipeline Header	
Volume (cu-ft)	10000	
Saturation >5% (N=0,Y=1)	0	$4,444
Item:	Old Plant Site	
Volume (cu-ft)	1000	
Saturation >5% (N=0,Y=1)	0	$444
Item:	Compressor	
Volume (cu-ft)	800	
Saturation >5% (N=0,Y=1)	1	$593
# Tank Batteries	3	$12,000
# of Tanks	9	$13,500
# Test Stations	2	$8,000
Other Soils (ie. Comp. etc) cu-ft		$0
Special Considerations		
Asbestos (lin. ft. or sq. ft.)	0	$0
PCB's (# of Transformers)	3	$4,500
NORM (lbs. of waste)	100	$2,000
Haz. Waste (cu-ft)	0	$0
Underground Tanks	1	$5,000
Dumps -Remove (cu-yds)	0	$0
Dumps - Cover (sq. yds.)	0	$0
Drums	2	$2,000
Other:		
Total Environmental Restoration Costs		$84,789
** Facility Abandonment**		
Amine Units	0	$0

Item	Input Data	Cost
Building Foundation (sq. ft.)	500	$75
Buildings sq. ft.	5000	$6,500
Chemical Storage Areas	1	$450
Circulating Pumps	2	$420
Compressors (HP)	100	$350
Concrete Bases (include well sites)	68	$20,060
Control Valves	4	$396
Dehydrators (MMSCF Rating)	5	$2,490
Electrical Panels	7	$3,675
Fence (ft.)	1078	$119
Flare Systems	1	$700
FWKO's	1	$1,700
Heater Treaters	3	$3,900
LACT Units	1	$1,100
Loading Docks	0	$0
Metering Systems	1	$110
Misc. Vessels:	6	$2,274
Pads (acres)	4	$5,200
Piping (ft.)	15000	$14,700
Pumps w/ Motors (Misc)	6	$1,170
Tanks, Misc.	1	$800
Tanks: Oil and Water	9	$7,200
Transformers	6	$660
Utility Poles:	103	$2,833
VR Units	2	$1,190
Other:		
Pipelines to be Removed		
Size	3	
Length (ft)	100	
Depth (ft)	3	$400
Roads to be Removed		
Miles	0.5	$550
Total Facility Demolition Cost		$79,021
** Well Abandonment Costs **		
Producing Well Count	57	$293,550
Pad area sq-ft	20000	$31,405
Injection Well Count	15	$77,250
Pad area sq-ft	5000	$2,066
Other (TA etc.) Well Count	5	$25,750
Pad area sq-ft	5000	$689
Average Depth	5000	
Total Well Abandonment Costs		$430,710
Total Costs		$594,520
Net Costs:		
-Environmental Restoration		$63,592
- Facility Demolition		$59,266
- Well Abandonment		$323,032
Total Costs (Net)		$445,890

Fig. 2 - Example Cost Estimating Program Results

STATISTICAL ESTIMATION SPREADSHEET

This spreadsheet will calculate confidence intervals for the mean
(Note: Maximum of 30 data input points.)

Directions: Input measured values in the column titled "Measured Value."
The program will calculate the standard deviation, average and the various confidence limits.

Title: SPE Paper Example: Well Depths

INPUT DATA

Item Number	Measured Value	Item Number	Measured Value
#1-1	6789	#3-9	7114
#1-11	6588	#3-2	6842
#1-16	6808	#3-56	6952
#1-10	6345	#3-6	6542
#1-2	6789	#3-5	6789
#1-13	6581	#3-10	7001
#1-14	6489	#3-11	6234
#1-5	6713	#3-12	6529
#1-15	6715	#3-4	5989
#2-1	6619	#3-70	6304
#2-6	6458	#3-69	6786
#2-7	6786	#3-71	6327
#2-8	6891	#3-79	6871
#2-12	6432	#3-98	6891
#2-18	7011	#3-88	6897

CALCULATED DATA

Std. Dev. =	263.46
Number of Tests =	30.00
Average =	6669.40

Confidence Limit of True Mean

Confidence Limits		Upper	Lower
90% Conf. Limit=	79.12	6748.52	6590.28
95 % Conf. Limit =	94.28	6763.68	6575.12
99% Conf. Limit =	123.90	6793.30	6545.50

Fig. 3 - Example Statistical Estimation Results

ENVIRONMENTAL LEASE REVIEWS
(Please answer the questions below and return the questionnaire in the envelope provided)

LEASE NAME: ____________________

LOCATION: ____________________

A. PRODUCTION

1. Oil _______ BOPD
2. Water _______ BWPD
3. Gas _______ MSCFD

B. WELLS (Typical Well Depth ______ ft.)

1. Oil Wells
   a. _____ Flowing
   b. _____ Artificial Lift
2. Gas Wells
   a. _____ Flowing
   b. _____ Artificial Lift
3. Injection Wells
   a. _____ Water
   b. _____ CO2 or Gas
   c. _____ Other (Polymer, Steam etc..)
4. Service Wells
   a. _____ Water Supply
   b. _____ Salt Water Disposal
   c. _____ Other (Explain: ____________)
5. Inactive Wells
   a. _____ TA'd
   b. _____ Shut In

C. Field Gathering and Treating Facilities

1. Oil or Gas Field
   a. _____ Tank Batteries or Central Treating Facilities
   b. _____ Central Injection Facilities (If Separate)
   c. _____ Number of Satellite Test Stations (If Applicable)
   d. _____ Other Field Gathering and Oil Treating Facilities (Explain: ________________)
   e. _____ Number of Oil and Water Stock Tanks in a thru d
   f. _____ Lined _____ Unlined Earth Pits (Size _____ft.x _____ ft.x _____ft.)
2. Gas Field
   a. _____ Number of Compressors
   b. _____ Number of Glycol Units
   c. _____ Number of Amine Units
   d. _____ Describe Other Gas Treating Equipment (Refrigeration, Lean Oil etc..) ___________

Fig. 4 - Co-Owner Questionnaire

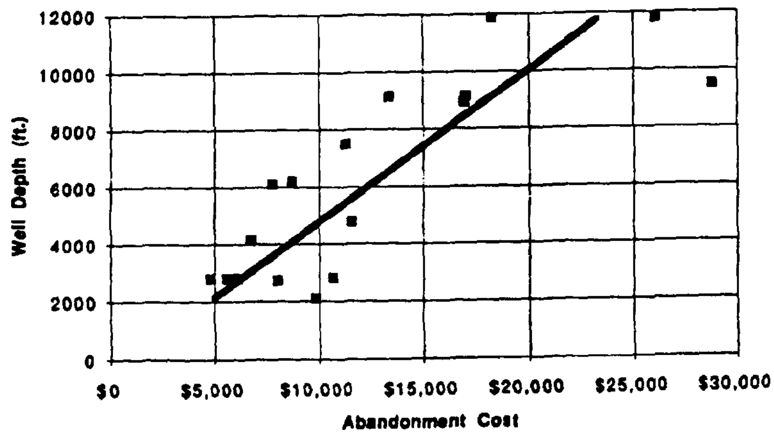

Fig. 5 - Example Well Abandonment Cost Plot

Property Abandonment and Environmental Remediation and Restoration

Example Cost Estimate

1. Air Exchangers	
Site Demo. (3 Man RB Crew 1 Day)	$432.00
Crane (4 Hrs. Min.)	$480.00
Trucking	$200.00
Concrete Pad and Misc. (1Day: Crew and Bkhoe)	$864.00
Total	**$1976.00**
2. Casing Vent Collection Systems	
Site Demo. (3 Man RB Crew 2 Days)	$864.00
Crane (4 Hrs Min)	$480.00
Trucking	$200.00
Concrete Pad and Misc. (1Day: Crew and Bkhoe)	$864.00
Total	**$3272.00**
3. Floatation Unit (Wemco)	
Site Demo. (3 Man RB Crew 1 Day)	$432.00
Crane (4 Hrs. Min.)	$480.00
Trucking	$200.00
Concrete Pad and Misc. (1Day: Crew and Bkhoe)	$864.00
Total	**$1976.00**
4. Typical 10' by 40' Skid	
Site Demo. (3 Man RB Crew for 5 Days)	$2160.00
Crane (1 Day)	$ 960.00
Trucking (2 Days)	$ 400.00
Concrete Pad and Misc. (2 Days: Crew and Bkhoe)	$1728.00
Electrician (3 Days @ $40/ hr)	$960.00
Misc. (Nitrogen, etc)	$1292.00
Total	**$7500.00**
5. Truck Loading Rack	
Site Demo. (3 Man RB Crew for 3 Days)	$1296.00
Trucking (1 Days)	$ 200.00
Concrete Pad and Misc. (1 Days: Crew and Bkhoe)	$864.00
Misc. (Nitrogen, etc)	$500.00
Total	**$2860.00**

Fig. 6 - Example Equipment Demolition Estimate