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Compression Service Contracts – When is it Worth it?

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ABSTRACT

It is not uncommon to face a situation when we need to make capital investment decisions to increase transportation capacity of a pipeline under uncertainties such as market development, project costs, schedule and so forth.

This was the situation we faced related to the energy shortage in Brazil that prompted for the need of alternative and reliable energy sources that could be put into operation in a short period of time based on many prospective Gas Fired Power Plant projects but without having the necessary agreements signed.

The Ministry of Mines and Energy of Brazil set a program addressing initially 53 thermo power plants totaling about 19,363 MW. From this total 17,577 MW of installed power was from 47 gas fired power plants demanding gas volumes in the range of 88 MMm3/d, most of this power was to be available from 2001 to 2003.

With this challenge, Petrobras has started to design a gas pipeline network expansion plan with investments of more than 1 billion US$ for its system alone, including new gas pipelines, new compressor and custody transfer stations and loop lines, in addition to expansion projects for the Bolivia-Brazil Gas Pipeline in Bolivia (0.2 billion US$) and in Brazil (0.35 billion US$), and the new gas pipeline from Argentina to Brazil (0.25 billion US$).

Under this scenario we considered the option of contracting compression service for some pipelines in our networks as an alternative for conventional and fixed compressor stations while discussing the gas and transportation contracts and others investments.

We did a feasibility analysis for two alternatives of compression service contract and fixed compressor station, both using Monte Carlo Simulation Method. The results and methodology are presented in this paper.

INTRODUCTION

Petrobras Gas Pipeline Expansion Project has faced a challenging situation: How to get prepared for a very high growth scenario in demand related to the program of The Ministry of Mines and Energy of Brazil that addressed the installation of 53 thermo power plants totaling about 19,363 MW. From this total, 47 gas-fired power plants – GFPP totaling 17,577 MW, demanded gas volumes in the range of 88 MMm3/d that would more than double the installed gas pipeline transportation capacity since most of this power were to be available from 2001 to 2003. By the end of 2002, 4.6 GW of GFPP was already installed.

The energy shortage in Brazil prompted for the need of alternative and reliable energy sources that could be put into operation in a short period of time based on many prospective Gas Fired Power Plant projects but without having the necessary agreements signed.

Since that program was conceived in a changing scenario which also had undergone a market deregulation and the establishment of Brazil Regulatory Agency (ANEEL) and Energy Wholesale Market (MAE) and also considering that the prompt for all this program was the energy crisis in early 2001 due to a very low water level in the hydro plants reservoirs caused by a low rain precipitation, so fundamental to the hydro power generation, and also difficulties related to strategic decisions on the electric sector. Hydro power generation is more than 80 % of total of energy generation in Brazil, explaining how critical the crisis was.

To face that challenge we had to adopt a different approach with relation to how to expand transportation capacity and how to make investment decisions under uncertainties such as market growth, project costs, schedule and so forth.

We had started to design a gas pipeline network expansion plan with investments of more than 1 billion US$ for its system alone, including new gas pipelines, new compressor and custody transfer stations and loop lines, in addition to expansion projects for the Bolivia-Brazil Gas Pipeline in Bolivia (0.2 billion US$) and in Brazil (0.35 billion US$), and the new gas pipeline from Argentina to Brazil (0.25 billion US$).

To provide additional transportation capacity at a lower cost and tight schedule we considered the option of contracting compression service for some pipelines in our gas pipeline networks as an alternative to conventional and fixed compressor stations, while negotiating gas supply and transportation agreements and others investment decisions.

We did a feasibility analysis for two alternatives: compression service contract and fixed compressor station both using Monte Carlo Risk Analysis Simulation. The results and methodology are presented in this paper.

METHODOLOGY

Risk analysis simulation has been used with increasing frequency as a risk mitigation tool in replacement to sensitivity analysis based on scenarios (least, normal and most favorable) that do not cover all possible probabilistic events that a project is subject to (Hertz, 1964; Vose, 1996).

In this paper the Monte Carlo Risk Analysis Simulation is used and a practical example is presented to illustrate its applicability to projects, requiring the identification of probabilistic distributions of interest variables associated to the project in addition to the normally used information for investment decision analysis.

This practical example covers the economic feasibility analysis of two alternatives for the installation of a compressor station in a gas pipeline in Brazil to increase gas transport capacity:

- Fixed compressor station;
- Compression service contract from a specialized company – Service Co.

The construction and assembling of a compressor station by a transportation company – Transco – the company that holds right to transport or is proprietary of the gas pipeline, follows certain requirements which must be satisfied, a priori, for its implementation:

The signature of a ship or pay gas transportation agreement between Transco and Shipper – the company that holds the selling right or has its property and wants to sell the gas to the market using Transco to provide gas transportation;

A 24 months schedule required for the compressor station construction, assembling and commissioning;

Capital resources for equipment acquisition and construction and assembling agreements;

Qualified staff to operate and maintain the installation.

In the other hand Shipper will only sign the ship or pay agreement with Transco after having signed a take or pay agreement with the local gas distribution company – LDC, that company that holds the right for gas distribution to end users.

Making even more complex this gas business chain LDC will only sign the take or pay agreement with Shipper if also has take or pay agreements signed with major end users so as to have guaranties that will enable it to honor its contractual obligations.

We all know that all that contractual negotiations between companies, necessary to close the deal, requires months or even years to be accomplished relying on market maturity, gas price policies. This contributes for the uncertainties we face nowadays in Brazil gas market.

The agreement between Transco and Service Co. presents advantages that help the gas business chain. The shorter implementation schedule, in the range of 6 months, and the fact that this option do not require capital investment from Transco but only operational expense against compression service provided by Service Co. presents a very attractive option for Transco.

Methodological Steps

1. Define project configuration.
2. Identify project financing indexes to be achieved such as IRR, debt-equity ratio and debt interest rate.
3. Identify relevant items such as capital required for equipment acquisition, construction and assembling costs, revenues, taxes, general and administrative costs, depreciation criteria and other items.
4. Identify uncertain variables and define probability distribution and their parameters.
5. Create a project economic model using a spread sheet to evaluate NPV and IRR.
6. Use a risk analysis software (@Risk 4.5 in this case) linked to a spread sheet to carry out the simulations.
7. Define the configuration for the risk analysis model such as sampling method and parameters for the simulation (trials, simulation runs, random seeds, etc)
8. Statistic analysis of the results (tables and graphics).
9. If necessary, define new actions that may mitigate risk levels identified from the simulation.
10. If necessary, review and adjust the model so as to

satisfy return rate expectation of the project sponsors.

CASE STUDY

This case study is based on the Volta Redonda Compressor Station that was installed under a compression service contract on the Rio de Janeiro – Volta Redonda Gas Pipeline – GASPAL. The decision on signing a compression service contract instead of installing fixed compressor station has followed the methodological steps described on item 2 above and the details and results are presented on the next items.

Project History

Due to market development in Rio de Janeiro related to gas-fired power plants installation we had to anticipate 3.23 MMm3/d of incremental transportation capacity for the GASVOL gas pipeline so as to make Bolivian gas available to Rio de Janeiro market. We had a very tight schedule for the installation so we made a bid for contracting compressor service while we also analyzed the option of installing a fixed compressor station to have a way to evaluate the proposals received.

BUSINESS MODEL

The natural gas business model that makes the environment under which we analyzed this case study has a configuration that involves different interdependent players that wants to be protected from risks and therefore want to have agreements signed to cover them up.

With regard to compression service whenever there is a market opportunity to place more gas volumes Shipper will start negotiating with Gas Producers and LDC to have the ends meet. At the same time you start negotiation with Transco to have transportation capacity for the new demand. All of these deals takes time and are not an easy task in a new and under development gas market such as in Brazil.

The figure 1 illustrates this model focusing on the opportunity of having a fixed compressor station installed or a compression service contract to increase transportation capacity by 3.23 MMm3/d for GASVOL gas pipeline.

TECHNICAL, ECONOMIC AND COSTS DATA FOR COMPRESSOR STATION

The data provided in table 1 were adopted for the technical and economic evaluation.

For Fixed Compressor Station we estimate de costs based on a previous acquisition of Araucária Compressor Station that is similar to Volta Redonda Station and for Temporary Station we get cost information from Service Co. during the bidding process.

Other information:

Transco return rate:	15%
Service Co. return rate:	23.87% (based on contractual charges, see figure 2)
Transportation rates:	@NPV=0 and return rates for Transco and Service Co.
Contractual Schedule:	3, 6 and 9 years
Debt-equity ratio:	0% (without leverage)
Depreciation:	10% a year

Service Co. Return Rate Evaluation

We calculated the Service Co. return rate as 23.87% based on the contractual charges for a tree years contractual term and the station costs presented at the bid. The spread sheet seen in figure 2 shows all the cost items adopted and also includes some specific taxes applied in Brazil for this type of activity.

RISK ANALYSIS MODELING

The risk analysis modeling consists of selecting the uncertain variables of the project and its probabilistic distribution linked to the economic spread sheet and by using a risk analysis tool (@risk 4.0) permits to make a predefined number of runs that provide sampling results from a sorting process based on Monte Carlo Simulation. The aim was to verify how the project IRR and NPV would vary as a function of the simulation process.

Uncertainty Variables

Requires a thorough understanding of the project dependant variables that maight affect its economic results. For this kind of project we select Equipment and C&A Costs, Transported Volumes, C&A Schedule and Salvage Costs as shown in table 2a and 2b.

Transportation Rate Calculation

With the contractual revenues and Transco return rate evaluated previously described we calculated what would be the transportation rate on reference year (year 0), based on the transported volumes that would give the same revenues. We also considered as escalation factor of 0.5% a year for the transportation rate. This approach was carried out for each alternative and each possible contractual term (2 to 10 years) and the resulting rates were then kept unchangeable and become the basis for the risk analysis simulations performed for each alternative. See figures 3 and 4.

Risk Simulation Configuration

After having defined the basic spread sheet (figure 3), we included in the spread sheet the uncertainties, as figure 2a and 2b, set the probabilistic distribution types (normal and triangle) for each of then. We used @Risk 4.5 as the risk analysis simulation tool with the following functions:

=RiskNormal(U25, V25, RiskName("Equipment and C&A Cost"))
=RiskTrigen(U27, U28, U29, 10, 90, RiskName("C&A Schedule"))
=RiskTrigen(U30, U31, U32, 10, 90, RiskName("Salvage Cost"))
=RiskNormal(U33, V33, RiskName("Transported Volumes"))

We also set the simulator parameters such as:

Number of iterations:	500
Number of simulation:	1
Sampling type:	Latin Hypercube
Random generator seed:	1
Standard recalculation:	Expected Value
Collect Distribution Samples:	All

RISK SIMULATION

Running the simulation risk analysis we can produce tabular and graphic results that will allow us to visualize how risky is the alternatives and what measures we need to take if we find necessary to adjust some model values such as return rate or even spend more effort to narrow down the project uncertainties variables.

Risk Comparative Analysis

As we can see from the results presented in figures 5 to 9 the alternative of Compression Service Contract was the one who presented the lowest risk or the lowest variation of IRR and NPV, for years 3, 6 and 9, below their mean values. This shows, for the 3 years contractual term, that even in the worst sampled condition this alternative will still be the best, presenting a probability of 0.025 for having IRR lower than 14.62 % followed by 0.44% for Fixed Station with 24 months for C&A and -3.17% for Fixed Station with 12 months for C&A and . Same comparison can be done for the NPV.

As a consequence Transco should be moved to make additional efforts to mitigate its exposure such as:

Increase the project return rate – in this case this decision would place the Fixed Station alternatives in a less competitive position since transportation rate would increase as a direct consequence of the return rate increase.

Concentrate on project simplification, costs reduction, C&A schedule reduction and also to find a way to narrow down the variables uncertainty margin.

The table 3 presents a comparison between the alternatives.

Sensitivity Analysis

By running the sensitivity analysis we can see how the variation of one standard deviation of one uncertain variable will affect the objective function (IRR or NPV) and therefore we will visualize which of them worth concentrating additional effort to mitigate its influence on the total risk of the project. The tornado graphic type presents a regression for it uncertain variable and quantifies its influence for 3 and 9 years of contractual term as shown on figures 10 to 15.

CONCLUSIONS

This case study illustrates how important is the risk simulation for a project feasibility analysis under uncertainties. For example what would appear to be an attractive return such as 15% for Fixed Compressor Station with C&A of 12 months and 3 years contractual term, proved to have a probability of 0.025 (2.5%) to have a IRR lower than -3.17%, a probability of 0.16 (16%) to have IRR lower than 4.28% and finally a probability of 0.5 (50%) to have IRR lower than 11.73%.

For the Compression Service Contract the figures are much better and we have a probability of 0.025 (2.5%) to have an IRR lower than 14.62%, a probability of 0.16 (16%) to have IRR lower than 17.98% and finally a probability of 0.5 (50%) to have IRR lower than 21.34%.

Based on this practical experience we can see the benefit of the Monte Carlo Risk Simulation for a project feasibility analysis. By doing this analysis we succeed in overcoming a prevailing paradigm which stated that a fixed compressor station was ever a better economic option to increase transportation capacity of a gas pipeline.

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TABLES

		Araucária Station	Volta Redonda Station	
Items	**units**	**Fixed Station**	**Fixed Station**	**Service Contract**
Moto-compressor	hp	4 x 1195	4 x 1600	4 x 1600
Generator set	kVa	2 x 650	2 x 650	1 x 43
Maximum flow	MMm3/d	4.08	5.95	5.95
Suction pressure	Kgf/cm2g.	45	38	38
Discharge	Kgf/cm2g.	70	65	65
Cost of Equipment	US$	7,411,084.00	9,234,003.72	4,402,455.00
C&A Cost	US$	4,328,002.00	4,328,002.00	1,989,152.00
Total installation	US$	11,739,086.00	13,562,005.72	6,391,607.00

Table 1 – Compressor Stations Data

Uncertainties	Type	Mean (μ)	Standard Deviation (σ)
Equipment and C&A costs	Normal (μ, σ)	100%	11.26% (3%)*
Transported Volumes	Normal (μ, σ)	100%	5%

* Is lower for Service Co. since most equipment is on stock.

Table 2a – Uncertainty Variables

Uncertainties	Type	Limits	Compression Service Contract	Fixed Station C&A 12 months	Fixed Station C&A 24 months
C&A Schedule	Triangle, 10/90	Bottom Value	10	10	20
		Most Likely	12	12	24
		Top Value	14	14	28
Salvage Cost	Triangle, 10/90	Bottom Value	70	60	60
		Most Likely	90	80	80
		Top Value	100	100	100

Table 2b – Uncertainty Variables

		IRR %			NPV, US$ x 10^6		
		(2 x σ)	(σ)	Mean	(2 x σ)	(σ)	Mean
Probability (*)		0.025	0.16	0.5	0.025	0.16	0.5
Compression Service Contract C&A 12 months	3 years	14.62	17.98	21.34	-1.030	-0.656	-2.820
	6 years	18.50	20.84	23.18	-0.888	-0.502	-0.116
	9 years	19.54	21.57	23.60	-0.863	-0.459	-0.055
Fixed Station C&A 12 months	3 years	-3.17	4.28	11.73	-4.390	-2.635	-0.883
	6 years	4.30	9.31	14.32	-3.936	-2.154	-0.372
	9 years	6.48	10.74	15.00	-3.842	-1.984	-0.126
Fixed Station C&A 24 months	3 years	0.44	6.34	12.24	-4.020	-2.427	-0.831
	6 years	5.97	10.14	14.31	-3.592	-1.980	-0.368
	9 years	7.74	11.33	14.92	-3.477	-1.810	-0.143

(*) Probability of achieving values below the ones indicated in the table for IRR and NPV

Table 3 – Risk Comparison Table

FIGURES

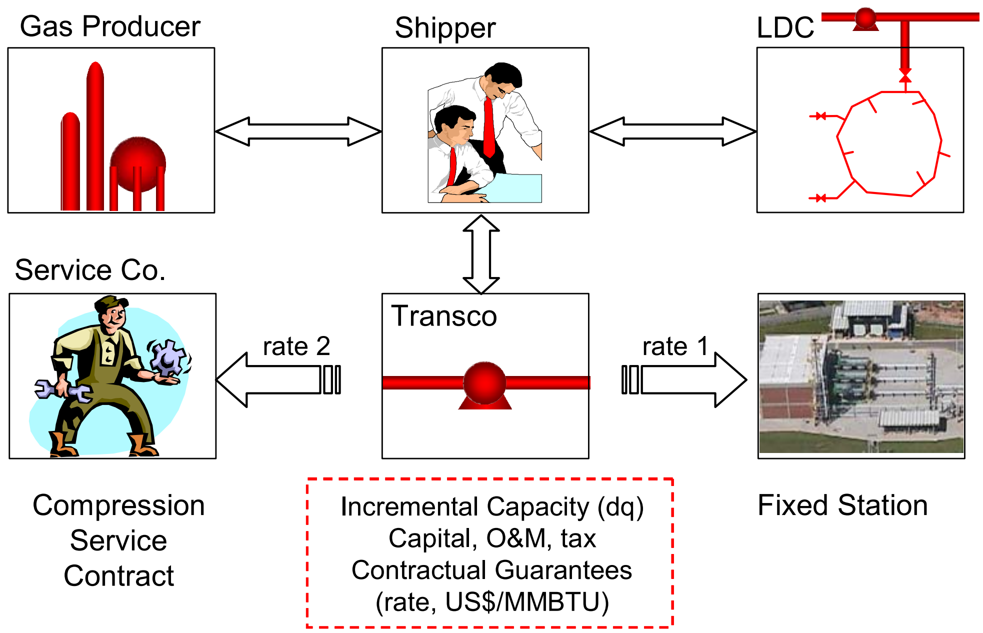


Figure 1 – Business Model

Income Statement		0	1	2	3
Contractual Revenues			2,781,751	4,367,736	4,586,123
Present Value @ 15%		8,737,000			
Pis & Cofins (Brazilian tax)	3.65%		101,534	159,422	167,393
Net Operation Revenue			2,680,217	4,208,313	4,418,730
O&M + Desmobilization cost			330,766	342,342	1,062,973
EBITDA			2,349,451	3,865,971	3,355,756
Depreciation			1,174,686	1,174,686	1,174,686
EBT			1,174,766	2,691,286	2,181,071
Social Contribution (Brazilian tax)	9.00%		105,729	242,216	196,296
Income Tax	25.00%		293,691	672,821	545,268
Net Revenue			775,345	1,776,248	1,439,507
Cash Flow		**0**	**1**	**2**	**3**
Net Revenue			775,345	1,776,248	1,439,507
Depreciation			1,174,686	1,174,686	1,174,686
Salvage Cost			-	-	2,867,550
Net Revenue + Depret. + Salvage Cost			1,950,031	2,950,934	5,481,742
Capital Investment		-6,391,607			
Free Cash Flow		-6,391,607	1,950,031	2,950,934	5,481,742
IRR	23.87%				
NPV	15.00%	1,139,737			

Figure 2 – Service Co. Return Rate Evaluation

		0	1	2	3
Incremental Capacity (m3/d)			2,160,000	3,230,000	3,230,000
Transportation rate (US$/MMBTU)	0,1008		0,1013	0,1018	0,1023
Gross Revenue			2,913,284	4,378,221	4,400,112
Present Value @ 15%		8,737,000			
Pis & Cofins (Brazilian tax)	3.65%		106,335	159,805	160,604
Net Operation Revenue			2,806,949	4,218,416	4,239,508
O&M + Desmobilization cost			330,766	342,342	1,062,973
EBITDA			2,476,184	3,876,074	3,176,535
Depreciation			1,174,686	1,174,686	1,174,686
EBT			1,301,498	2,701,388	2,001,849
Social Contribution (Brazilian tax)	9.00%		117,135	243,125	180,166
Income Tax	25.00%		325,375	675,347	500,462
Net Revenue			858,989	1,782,916	1,321,220
Cash Flow		0	1	2	3
Net Revenue			858,989	1,782,916	1,321,220
Depreciation			1,174,686	1,174,686	1,174,686
Salvage Cost			-	-	2,867,550
Net Revenue + Depret. + Salvage Cost			2,033,674	2,957,602	5,363,456
Capital Investment		-6,391,607			
Free Cash Flow		-6,391,607	2,033,674	2,957,602	5,363,456
IRR	23.87%				
NPV	15.00%	1,139,737			

Figure 3 – Base Spread Sheet for Transportation Rate Calculation

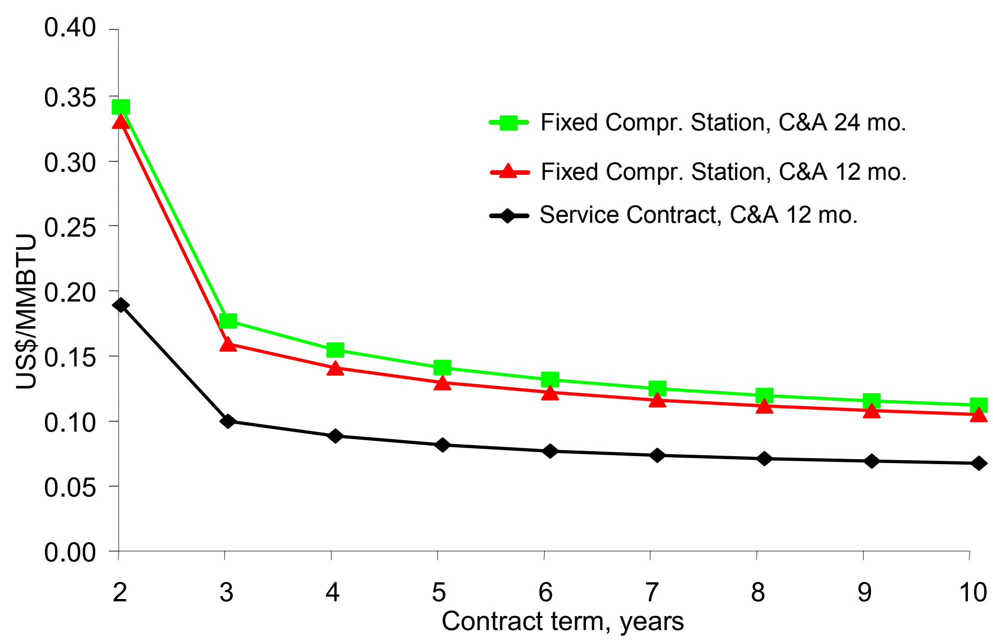


Figure 4 – Transportation Rate Comparison

@RISK Output Details Report

Output Statistics

Outputs	IRR do Projeto	NPV @ Ano 0	IRR do Projeto	NPV @ Ano 0	IRR do Projeto	NPV @ Ano 0
Simulation#	1	1	1	1	1	1
Worksheet	Serv_MC_12m	Serv_MC_12m	Perm_MC_12m	Perm_MC_12m	Perm_MC_24m	Perm_MC_24m
Statistics / Cell	B49	C50	B49	C50	B49	C50
Minimum	12.58%	(1,275,903)	-6.92%	(5,784,171)	-5.54%	(5,932,864)
Maximum	32.62%	938,452	41.13%	4,826,401	41.82%	5,418,565
Mean	21.34%	(282,012)	11.73%	(882,594)	12.24%	(830,521)
Standard Deviation	3.36%	374,066	7.45%	1,752,362	5.90%	1,596,034
Variance	0.11%	139,925,672,280	0.56%	3,070,771,515,854	0.35%	2,547,326,001,879
Skewness	0.066	0.036	0.468	0.033	0.380	-0.018
Kurtosis	2.976	2.977	3.548	3.003	3.933	3.138
Number of Errors	0.000	0.000	0.000	0.000	0.000	0.000
Mode	20.06%	(373,925)	15.32%	(679,284)	18.82%	(959,863)
5%	15.47%	(928,590)	0.26%	(3,792,334)	3.19%	(3,545,958)
10%	16.97%	(765,907)	3.10%	(3,013,574)	4.70%	(2,968,668)
15%	17.82%	(666,727)	4.51%	(2,624,002)	6.00%	(2,505,941)
20%	18.44%	(599,910)	5.56%	(2,325,291)	7.48%	(2,149,240)
25%	19.00%	(544,282)	6.48%	(2,100,112)	8.37%	(1,881,439)
30%	19.56%	(470,063)	7.11%	(1,851,365)	9.06%	(1,629,774)
35%	20.07%	(410,676)	8.57%	(1,549,800)	10.00%	(1,399,379)
40%	20.45%	(379,578)	9.30%	(1,337,962)	10.59%	(1,214,924)
45%	21.01%	(313,445)	10.20%	(1,135,458)	11.20%	(1,028,790)
50%	21.31%	(280,892)	11.15%	(896,947)	11.83%	(826,348)
55%	21.83%	(223,436)	11.97%	(687,638)	12.83%	(583,274)
60%	22.26%	(179,941)	12.77%	(526,970)	13.27%	(460,079)
65%	22.57%	(143,902)	13.89%	(259,450)	13.98%	(256,104)
70%	23.10%	(82,827)	15.01%	3,101	15.14%	38,209
75%	23.55%	(34,720)	16.46%	336,531	16.20%	304,577
80%	24.23%	39,019	18.05%	681,340	17.16%	551,085
85%	24.64%	88,023	19.57%	965,298	18.41%	885,302
90%	25.50%	187,235	21.34%	1,372,660	19.72%	1,147,232
95%	26.81%	329,994	24.47%	1,997,148	22.08%	1,718,410

Figure 5 – Risk Simulation Result for 3 Years Contractual Term

@RISK Output Details Report

Output Statistics

Outputs	IRR do Projeto	NPV @ Ano 0	IRR do Projeto	NPV @ Ano 0	IRR do Projeto	NPV @ Ano 0
Simulation#	1	1	1	1	1	1
Worksheet	Serv_MC_12m	Serv_MC_12m	Perm_MC_12m	Perm_MC_12m	Perm_MC_24m	Perm_MC_24m
Statistics / Cell	B49	C50	B49	C50	B49	C50
Minimum	16.28%	(1,238,508)	2.72%	(5,665,305)	2.67%	(5,197,381)
Maximum	30.23%	1,062,458	33.32%	4,928,246	34.03%	5,474,411
Mean	23.18%	(116,159)	14.32%	(372,051)	14.31%	(367,877)
Standard Deviation	2.34%	385,717	5.01%	1,782,452	4.17%	1,611,762
Variance	0.05%	148,777,694,961	0.25%	3,177,135,183,325	0.17%	2,597,777,879,624
Skewness	0.004	-0.034	0.474	0.030	0.360	-0.052
Kurtosis	2.882	2.894	3.408	2.934	3.587	2.933
Number of Errors	0.000	0.000	0.000	0.000	0.000	0.000
Mode	23.18%	(225,287)	13.26%	(1,391,466)	14.28%	(1,019,016)
5%	19.32%	(758,617)	6.72%	(3,348,769)	7.74%	(3,088,652)
10%	20.09%	(629,236)	8.28%	(2,646,587)	9.13%	(2,366,110)
15%	20.60%	(538,493)	9.61%	(2,127,709)	9.96%	(2,049,200)
20%	21.05%	(463,151)	10.14%	(1,888,694)	10.62%	(1,785,154)
25%	21.49%	(383,700)	10.78%	(1,589,688)	11.49%	(1,441,203)
30%	21.99%	(308,199)	11.70%	(1,244,669)	12.06%	(1,198,685)
35%	22.30%	(257,247)	12.19%	(1,041,655)	12.50%	(1,013,379)
40%	22.57%	(213,998)	12.73%	(857,178)	13.04%	(763,020)
45%	22.93%	(157,872)	13.22%	(663,097)	13.52%	(579,332)
50%	23.16%	(116,733)	13.79%	(447,667)	14.17%	(318,480)
55%	23.49%	(61,149)	14.44%	(204,355)	14.59%	(160,955)
60%	23.79%	(13,488)	15.06%	22,996	15.16%	62,437
65%	24.16%	45,526	15.73%	250,968	15.75%	278,079
70%	24.52%	104,317	16.52%	525,610	16.45%	544,279
75%	24.81%	151,276	17.40%	800,346	17.00%	736,418
80%	25.18%	216,443	18.60%	1,236,779	17.85%	1,062,664
85%	25.49%	266,119	19.79%	1,596,401	18.69%	1,339,627
90%	25.97%	352,627	21.21%	2,030,567	19.81%	1,708,227
95%	26.97%	512,316	22.49%	2,443,378	20.89%	2,111,327

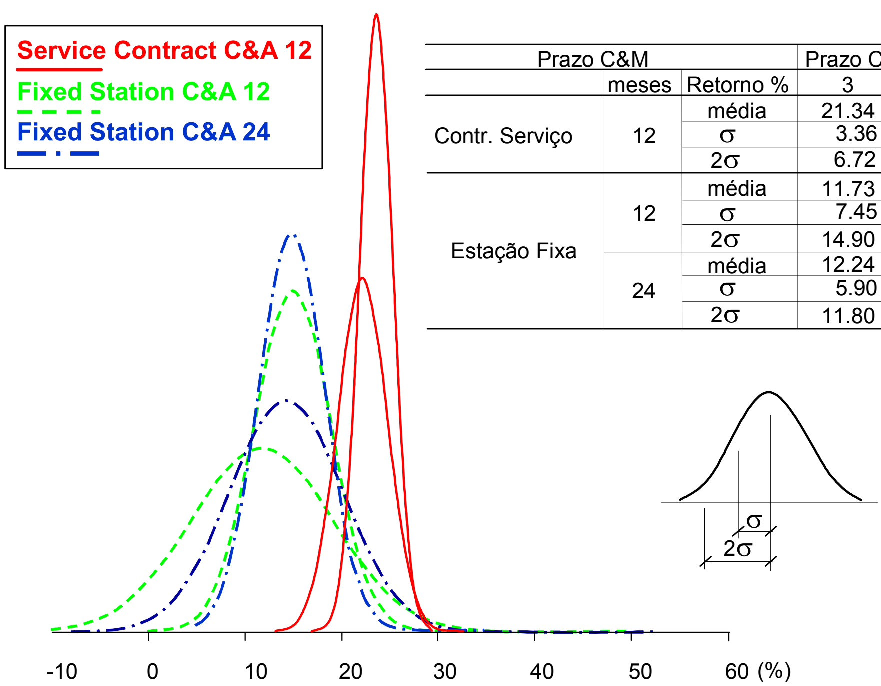
Figure 6 – Risk Simulation Result for 6 Years Contractual Term

@RISK Output Details Report

Output Statistics

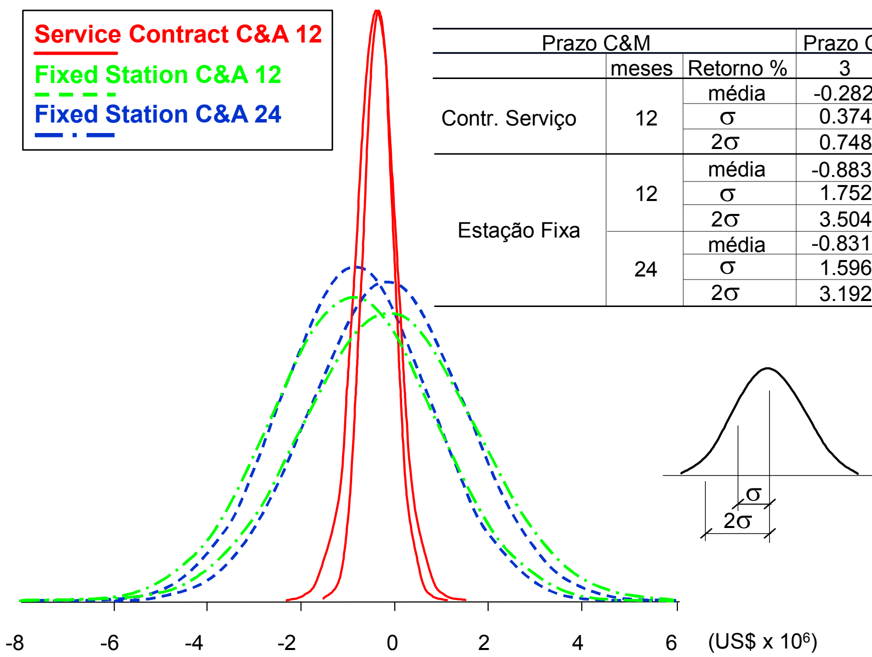
Outputs	IRR do Projeto	NPV @ Ano 0	IRR do Projeto	NPV @ Ano 0	IRR do Projeto	NPV @ Ano 0
Simulation#	1	1	1	1	1	1
Worksheet	Serv_MC_12m	Serv_MC_12m	Perm_MC_12m	Perm_MC_12m	Perm_MC_24m	Perm_MC_24m
Statistics / Cell	B49	C50	B49	C50	B49	C50
Minimum	16.99%	(1,329,295)	4.55%	(5,805,431)	5.55%	(4,961,733)
Maximum	29.57%	1,116,979	30.80%	5,024,203	31.29%	5,550,583
Mean	23.60%	(54,690)	15.00%	(126,051)	14.92%	(143,545)
Standard Deviation	2.03%	404,291	4.26%	1,858,403	3.59%	1,666,530
Variance	0.04%	163,450,969,914	0.18%	3,453,662,286,031	0.13%	2,777,322,040,573
Skewness	-0.034	-0.060	0.452	0.027	0.326	-0.078
Kurtosis	2.906	2.899	3.341	2.907	3.492	2.896
Number of Errors	0.000	0.000	0.000	0.000	0.000	0.000
Mode	23.72%	263,184	14.70%	(135,201)	14.96%	513,210
5%	20.38%	(705,070)	8.24%	(3,273,031)	9.18%	(2,965,099)
10%	20.92%	(595,078)	9.74%	(2,541,946)	10.37%	(2,266,818)
15%	21.45%	(478,022)	10.77%	(2,018,625)	11.23%	(1,875,107)
20%	21.79%	(412,250)	11.44%	(1,694,579)	11.78%	(1,599,832)
25%	22.13%	(350,231)	12.11%	(1,348,122)	12.50%	(1,255,913)
30%	22.48%	(272,944)	12.65%	(1,066,889)	12.93%	(1,022,272)
35%	22.85%	(199,702)	13.15%	(842,607)	13.36%	(811,621)
40%	23.10%	(153,267)	13.67%	(590,933)	13.77%	(585,346)
45%	23.35%	(104,340)	14.08%	(405,110)	14.31%	(319,699)
50%	23.56%	(61,546)	14.64%	(148,121)	14.70%	(145,181)
55%	23.85%	(3,325)	15.07%	27,961	15.23%	110,885
60%	24.15%	55,918	15.63%	268,603	15.81%	343,648
65%	24.49%	121,911	16.22%	543,788	16.21%	556,970
70%	24.79%	181,145	16.83%	769,565	16.72%	789,099
75%	25.11%	248,205	17.58%	1,074,900	17.23%	1,047,193
80%	25.26%	284,989	18.56%	1,513,967	17.94%	1,308,190
85%	25.66%	349,448	19.54%	1,899,552	18.71%	1,629,849
90%	26.13%	445,668	20.78%	2,323,333	19.46%	1,954,648
95%	26.89%	597,384	22.21%	2,892,881	20.54%	2,346,589

Figure 7 – Risk Simulation Result for 9 Years Contractual Term



Prazo C&M	meses	Retorno %	Prazo Contr. / Anos Oper. 3	9
Contr. Serviço	12	média	21.34	23.60
		σ	3.36	2.03
		2σ	6.72	4.06
Estação Fixa	12	média	11.73	15.00
		σ	7.45	4.26
		2σ	14.90	8.52
	24	média	12.24	14.92
		σ	5.90	3.59
		2σ	11.80	7.18

Figure 8 – IRR Risk Comparison for 3 and 9 Years Contractual Term



Prazo C&M			Prazo Contr. / Anos Oper.	
	meses	Retorno %	3	9
Contr. Serviço	12	média	-0.282	-0.055
		σ	0.374	0.404
		2σ	0.748	0.808
Estação Fixa	12	média	-0.883	-0.126
		σ	1.752	1.858
		2σ	3.504	3.716
	24	média	-0.831	-0.143
		σ	1.596	1.667
		2σ	3.192	3.334

Figure 9 – NPV Risk Comparison for 3 and 9 Years Contractual Term

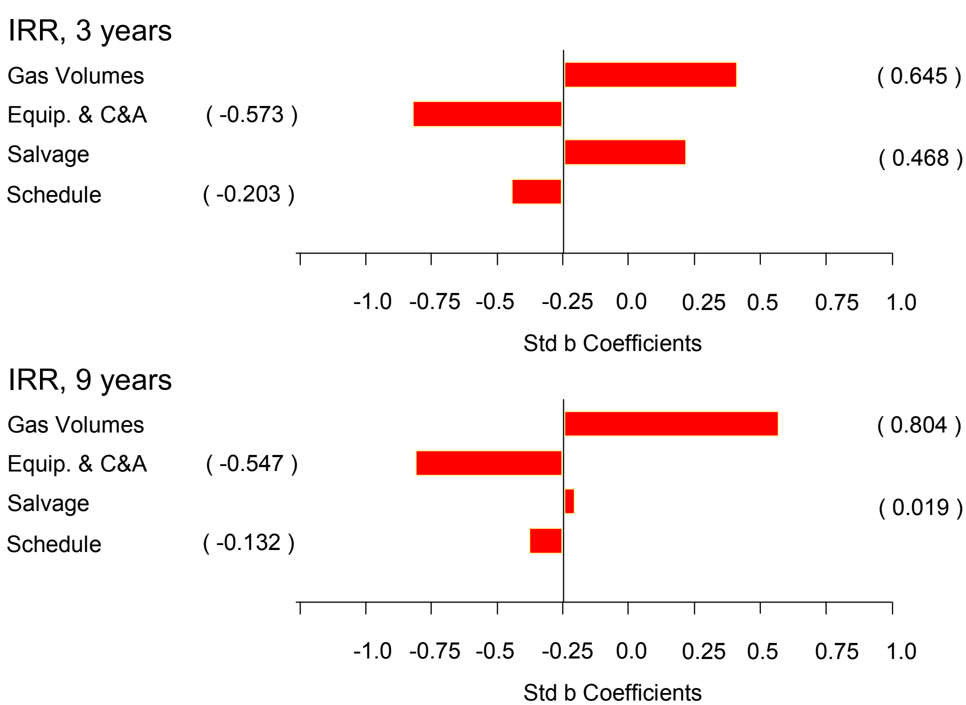


Figure 10 – IRR Sensitivity Analysis for Compression Service Contract – 3 and 9 Years Contractual Term

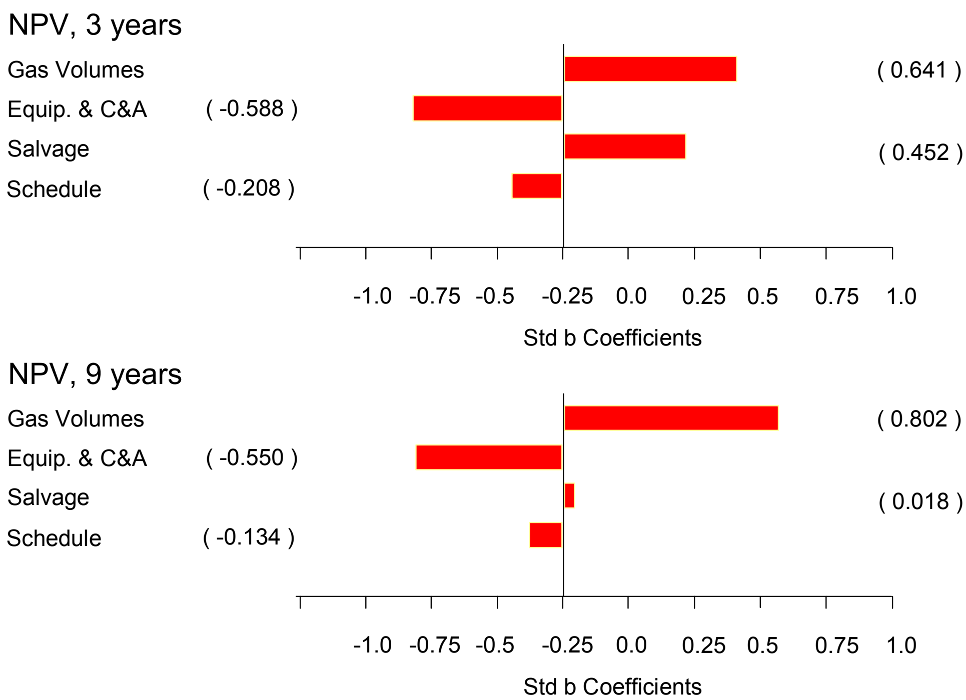


Figure 11 – NPV Sensitivity Analysis for Compression Service Contract – 3 and 9 Years Contractual Term

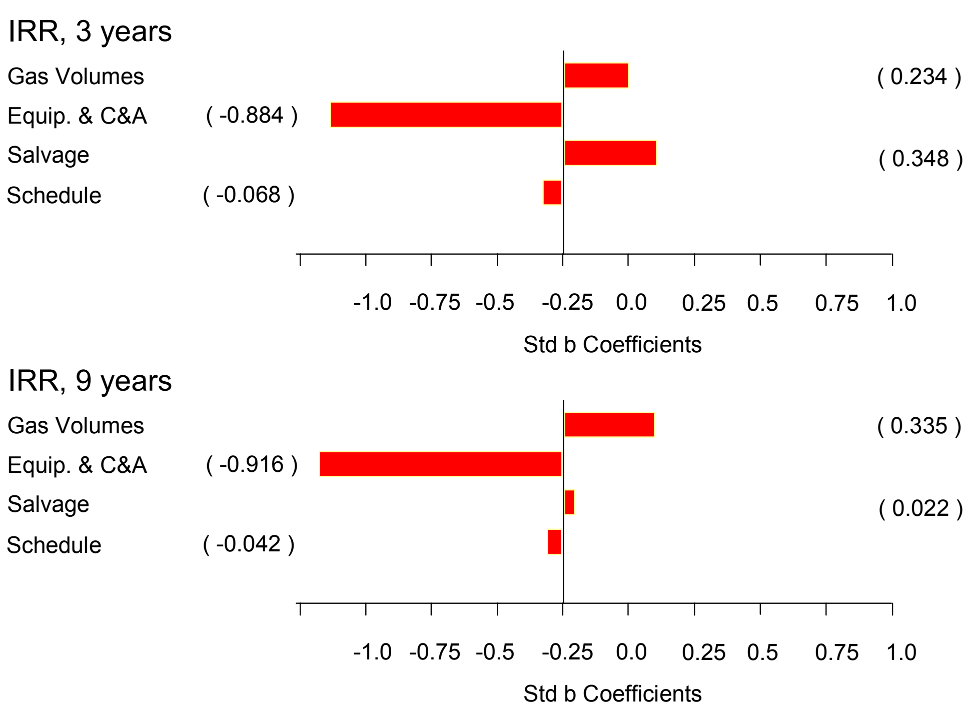


Figure 12 – IRR Sensitivity Analysis for Fixed Station C&A 12 months – 3 and 9 Years Contractual Term

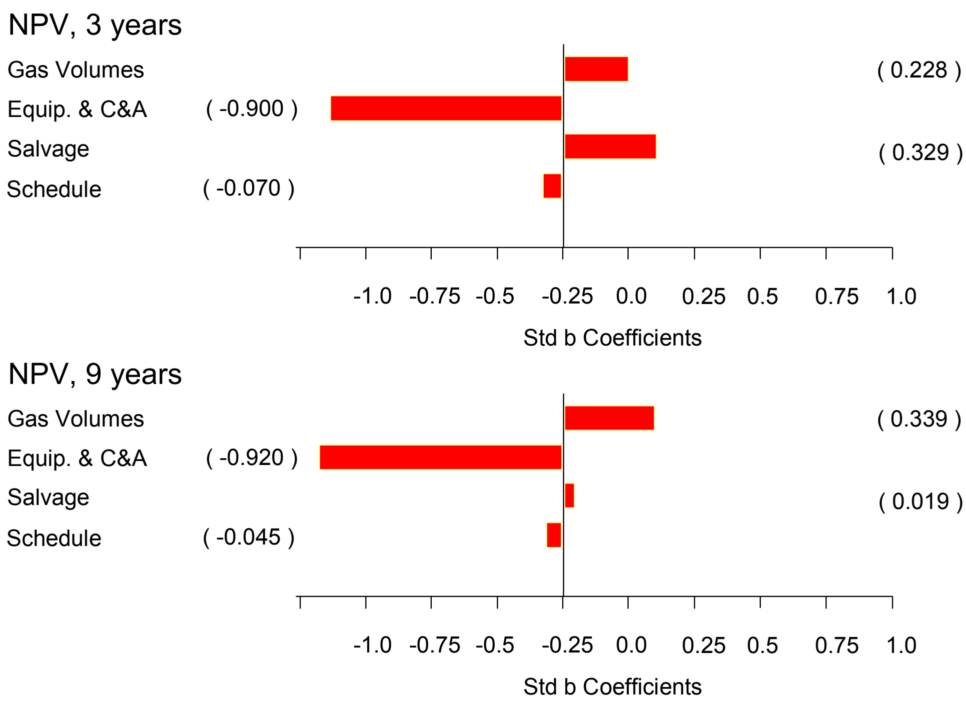


Figure 13 – NPV Sensitivity Analysis for Fixed Station C&A 12 months – 3 and 9 Years Contractual Term

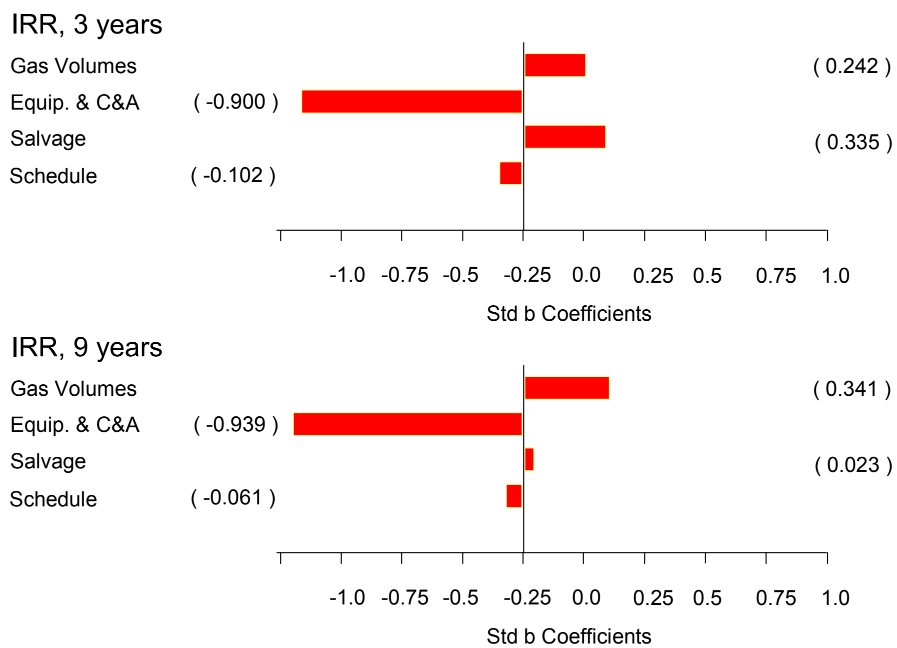


Figure 14 – IRR Sensitivity Analysis for Fixed Station C&A 24 months – 3 and 9 Years Contractual Term

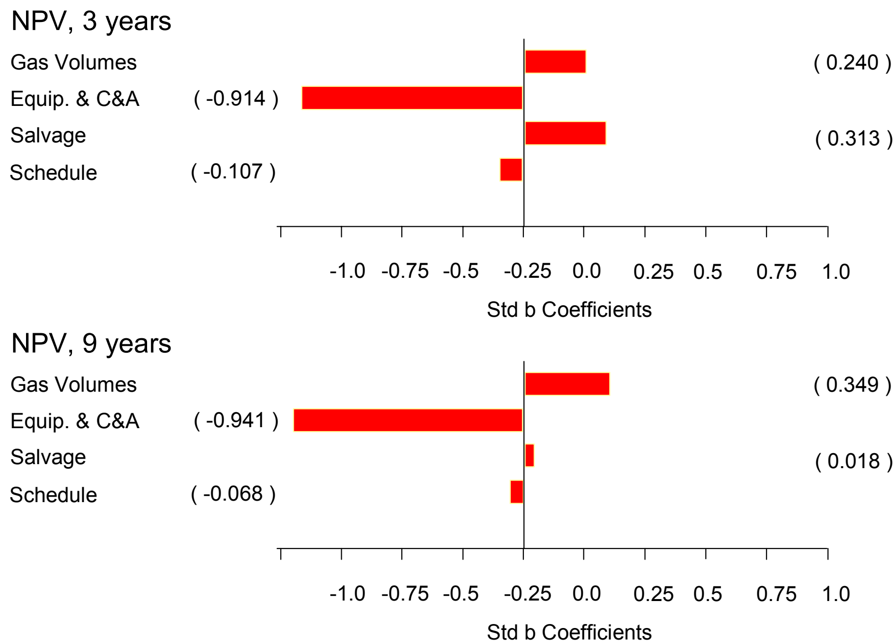


Figure 15 – NPV Sensitivity Analysis for Fixed Station C&A 24 months – 3 and 9 Years Contractual Term