

Extensive review on software testing and pipeline testing softwares

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ABSTRACT

The main aim of this paper is to explain the various types of testing techniques, methods and levels (functional, unit) which are being used by many Software industries. These software industries use these techniques to find faults or bugs in the final software created by them. Here the software testers are experts in the IT Industry who act like customers and review the software to check whether it completes the given requirement or not. To note down the requirements used in the software a matrix called the traceability matrix is used. This paper will provide an outline of all the testing techniques which are not only used in software industries but also in various offshore industries where pipeline testing is done to avoid any leakage on the welded joints, the quality of welds and the pressure, testing is done so that these pipes can be used for an entire lifetime which is designed for more than 25 years. For offshore pipes we use softwares to test the design and installation of a subsea pipeline. We go through some of the testing softwares like DNV-OS-F101, Fatfree, Sim buck and Offpipe.

Keywords-

DNV-OS-F101, Fatfree, Sim buck, Offpipe, Functional and Unit testing, Traceability Matrix.

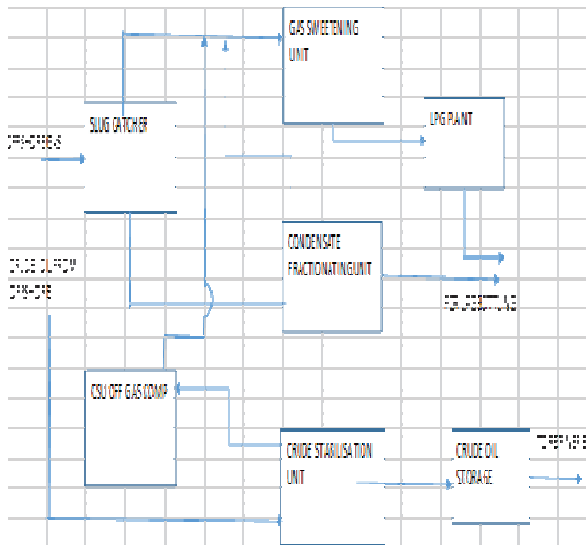
1. INTRODUCTION

Software Testing is a process which is done to evaluate and execute a software with its main aim to find errors and bugs in the software. It is a process where all software components in a system are evaluated or tested either with the help of automated tools or manually to check if the software made satisfies the requirements in the system or not. So, software testing not only checks the requirements to be used in the system but also finds bugs, errors or faults in the software. Software testing plays a major role in the growth of a multinational organisation. Software testing methods are also used in offshore pipeline

industries. Some softwares are used to test the design and installation process of a subsea pipeline.

1.1 ABOUT OFFSHORE

Offshore pipelines are pipelines which are built away from the shores. Hydrocarbons in the sea can be processed away from shore to avoid losses and reduce transportation costs. So, in view of this, the offshore platforms are constructed which extract multi-fluids from the natural reservoirs in the sea and product is transported from these offshore platforms to onshore for its further usage. There is a big network of subsea pipelines in the Indian Offshore, several platforms gather multifluid from the sea reservoir containing hydrocarbons which in various forms is transported to onshore processing facilities through these subsea pipelines. The platforms connected to these pipelines are unmanned and these pipelines are used to transport the product to onshore facilities for further testings. Pipeline leak detection had been the subject of constant evolution with more and more pipelines being installed and operated all over the world for various products, both liquid and gases. The software based leak detection, leak size and leak location systems have seen good success. The leak detection and leak location estimation in a liquid pipelines is more accurate and reliable as compared to gas pipelines since the gases are compressible and pipeline inventory modelling is more challenging and error prone. The basic premise of the leak detection system is to model the entire pipeline in a dynamic operating condition and then use various algorithms to predict and estimate the leaks based on continuous comparison of the modelled conditions of pressure and temperature with the actual parameters taken from the sensors along the pipeline.



The gas and the crude after evacuating or transporting from offshore is sent to the process plants for further processing or to refineries to obtain petrol, diesel etc. (fig 1)

2. TESTING SOFTWARES TO CHECK THE DESIGN OF A SUBSEA PIPELINE

2.1 DNV-OS-F101

It is a design test software for designing checks of a subsea pipeline. It does many tests including burst when ongoing operation for test of system pressure, collapse, propagation buckling, load combinations. It can calculate volume, mass and dry weight of pipeline components-Steel used, coating layers and other various contents. It is a very common test software in offshore industry. It calculates end expansion and simultaneously performs system pressure test. It plays a major role in upheaval buckling analysis test-when concrete is put on a pipeline under sea to decrease the buoyancy of the pipeline, the pipeline bends from the two ends due to weight put on the pipeline ends and this phenomenon is called the buckling of a pipeline.

2.2 Fat Free

It is a Virtual Basic for Applications software program to calculate the fatigue life due to inline and cross flow Vortex induced vibrations as well as direct wave loading, for current and wave induced loads (by doing this the actual lifespan of a pipeline is calculated after being exposed to different wave paths at various depths). It is also used to perform analysis of pipeline Free spans, this is done when

the software accepts a data, say the weight of a pipeline and sees whether the column (on which the pipe rests) can take the load of the subsea pipe or not. This software has a user friendly Microsoft Excel spreadsheet interface.

2.3 Sim Buck

This software is also known as 'Simplified Global Buckling Analysis'. It is a software which is used for Pre-buckling assessment for exposed pipelines. It also does Post-buckling which checks for exposed pipelines, including predicted feed-in length, maximum distance between buckles, and length of the buckle. A Recommended intervention measures to ensure minimum number of buckles through required curve radii or length of intermittent rock berms which may be present in the pipe and may break the pipe if they are sharp at points. It also measures the required soil backfill and additional cover height for buried pipelines for different seabed soil types, imperfection heights and trenching method.

3. TESTING SOFTWARE TO CHECK INSTALLATION OF A SUBSEA PIPELINE

3.1 OFFPIPE

It is a well-designed, limited element method based professional software program used in offshore engineering. It has been made especially for designing and analyzing structural problems associated with the installation and performance of subsea pipelines. It can be used for Static and dynamic pipe laying analysis for numerous lay barges and stinger configurations, both S-lay (also known as conventional where barge can directly lay the pipeline on the seabed by pushing the barge) and J-lay. It is used for Pipelay initiation, abandonment and recovery analysis. It can calculate stresses on stationary pipes, span lengths and deflections for non-uniform seabed scenarios. It also does static davit-lift analysis for conventional riser installations and subsea bend-ins.

4. FUNCTIONAL TESTING

Functional Testing is a type of black box testing which is used to test the new characteristics or properties of the new software made. The app is tested by giving the desired software and then examining and evaluating it to check the functionality of the software and to check the purpose it was needed for. There are various types of functional testings.

4.1 UNIT TESTING

It is the most basic form of functional testing which means testing of separate software components. This process is particularly performed by the programmer because it required high level knowledge of the program code. Sometimes, it may require the development of different types of test drivers. Unit testing means the testing of the most basic component of the software. Since it is the testing of a small component, bugs or errors are identified in an early phase which reduces the cost of further testing. Design can be changed and improved after errors are rectified.

4.2 INTEGRATION TESTING

In this phase the integrated components of the software are tested to check functionality of the software. Integration Testing is done when two or more tested parts of a system are joined together to form a bigger unit. The test is usually performed on both the interfaces between the components and the bigger structure being created, if its quality property cannot be judged from its component

4.3 SYSTEM TESTING

This includes the whole system working. In this phase we check whether the entire system is in working condition or not. Is it functioning the way it was intended to or not. Here, the tester should ensure the working and functioning is in accordance with the requirement document or not. In regression testing, the testers ensure if any fault or break has occurred after rectifying the bugs present in the system. Overall system is tested so that everything is in working condition and under stable environment.

4.4 ACCEPTANCE TESTING

It is done after system testing when the complete control of the project is handed over to the customers or users. It is done to ensure that the product meets the requirements of the users or not. It ensures whether the customers are able to perform their tasks with the product and their feedback is taken to improve the software. It further contains 2 more types of testings:

4.4.1 Alpha Testing:

First stage of acceptance testing which is performed in 99 groups. This phase is a combination of unit, integration and system testing. This phase rectifies small errors present in the

program such as mistakes in spellings, incomplete parts or links.

4.4.2 Beta Testing

This comes after alpha testing. This phase involves the evaluation and feedback of the product by end users or customers. Here a sample of the product is given to the audience to test whether it meets their requirements or not. This is the final phase of testing before making the product available to the public.

4.5 BLACK BOX AND WHITE BOX TESTING

Black box testing is done to check that the application made has the same output for all positive and negative inputs. This type of testing is mainly concerned with the functionality of the There are many types of black box testings, namely- equivalence testing, boundary value testing, error guessing etc. White box testing is a type of testing which deals with the internal working of the software. It is mainly concerned with the internal working of the software applications and is not concerned with the functionality of the same. High level programming skills are used to create test cases of the software and is done by experienced software engineers. Internal testings such as the testing of LOC (lines of code), programs, loops basic structure, objects, functions, classes etc.

5. PERFORMANCE TESTING

This is a test to check whether the newly designed software is giving a satisfactory performance to the user or not. This testing is not a part of functional testing and is used to check the performance of a newly designed software, whether it will be able to function under all environments or not. This type of testing includes all clock parameters like load, access, run and execution time. This also includes success rate, failure frequency, mean time between failures and overall reliability of software. The main testing done under performance testing are Load and Stress testing. Stress testing is a type of testing which is done on a system to check whether it will work under unfavourable conditions or not. Stress testing can also be defined as the ability or effectiveness of a computer system to withstand conditions outside its regular environment. Load testing is a process in which the tester situates a computer system to a high work rate so as to know its limitations. The tester comes to know of the

robustness of the system after performing this test. Since this process tests the endurance of the system, it is also known as endurance testing. This soak or endurance testing ensures that system will work under sufficient loads put to it for a significant period of time. Here the system leaks are detected by checking the memory of the system. The central aim of this soak test is to find out the system performance after a sufficient use. To calculate system efficiency and toughness, two things are calculated, namely-Mean Time To Repair (MTTR) and Mean Time Between Failures (MTBF). Spike testing is a type of testing which is done to increment the amount of users using the system so as to check the behaviour of the system after increased use of it over a significant period of time. Since it is very tough to test the load on the system manually, certain specific software testing tools are used to test the load. There are lots of freeware tools like Soap User Interface and quantitative. Load runner is a software tool which is most commonly used to test the performance of a software, IBM has also taken part in developing many software tools to test the software. Main failures occur in multi-national software industries because of poor performance testing.

6. SECURITY TESTING

Security testing is a type of testing to check whether the designed system secures data and information. This testing also checks whether the system is fulfilling user requirements while protecting data or not. This aims to protect the system and identify main risks and threats in the system. By detecting such threats and risks in the system, it helps developers to rectify these issues so that the application gives full functionality and is efficient. In object oriented systems, design level problems include error handling. Security risks include unprotected data channels, incorrect or missing access control mechanisms, lack of auditing, incorrect logging and timings and ordering errors. The system is tested for areas like authentication, authorization and different kinds of threats. This ensures that no one is able to hack into the company's designed system without any authorisation. Security testing of software is important as to protect the information, services, skills and resources of adversaries and the cost of potential assurance remedies. Security testing basically follows two types of approaches:

a. It tests the functionality of the designed software.

b. Tests the secureness of the software in case of any information leakage by using the system firewall.

Penetration Testing is a security testing type in which developers try to attack the security features of a system. Also known as Pen test, it is a type of attack done on purpose by the developers to check if the designed system can be attacked or can the data information be leaked.

There is another type of testing known as fuzz testing in which the developer makes a system crash on purpose by loading the system with unnecessary or random data so as to check the reaction of the system to this. In case of any system failures, the defects are informed to the developer. It was founded in 1988 by Barton Miller. It can be used to find any coding errors which may have been overlooked, made by the developer. This process does not guarantee full detection of errors or faults in a system. It can only find simple faults in a system and not complex errors. It does take a significant amount of time in the detection of simple bugs or errors.

Various statistical tests are used for testing of the softwares, to name a few of them;

- Independent t-test
- Paired t-test
- ANOVA
- MANOVA
- ANCOVA
- MANCOVA
- Chi-test
- Correlation
- Regression

These are defined below:

7. Bi-and Multivariate Inferential Statistical Tests

Bi variate statistics are used to compare two variables- categorical vs categorical or quantitative or categorical vs quantitative variables. Bi variate statistics are used when we have two categorical variables, and we want to know if they are related or not, whether there exists an association and the strength of this association (i.e., gender and score on outcome measurement). The Pearson product moment correlation coefficient and the independent group t-test are bivariate statistics'

The term “multivariate statistics” is used to determine which combination of variations is best out of all possible combinations.

7.1 CHI SQUARE

Chi square is a measure of significance and is used for finding the association between variables. It does not involve any assumption but the frequency of the cell should not fall below 5. It can be used to determine the strength of relationship though it is not a good measure of strength of association. It can tell us whether the relationship exists or not but it does not tell us about how strong it is.

For instance, we want to know whether any association exists between smoking of cigarettes and lung cancer. This association can be tested through chi square.

7.2 t-TEST

It can be defined as any statistical test which follows t-distribution under null hypothesis. Independent t-test is used to find the significant difference between the means in two groups which are not related. Out of these two groups, one continuous dependent variable and the second should be independent categorical variable that has two levels. It is applied when the statistic follows a normal distribution if the scaling term value in test statistic is known. If the probability of the F statistics is less than or equal to 0.05 then we can say that means are different.

For instance, if there are males and females studying in the same class and we want to know whether they differ in terms of their knowledge or their mental levels.

7.3 ANOVA

ANOVA is known as the ‘analysis of variance’. It was discovered by biologist and statistician Ronald Fisher. When there are means of three or more independent groups and the user wants to find whether there exists any statistically significant difference between the means of these groups. It simply tells the user that there is some difference between the groups without actually explaining that which group is different from the other groups.

For example whether different styles of teachings in the same class effect the knowledge of students or not. Here, the independent variable is the teaching style and dependent variable is the marks of the students in the examination. The T-test or F statistic tests are used when the groups have non-identical means. Like, when the probability of a

certain element is 0.05 calculated under F statistics, then the user can assume that the means are different.

7.4 ANCOVA

ANCOVA means the ‘Analysis of Covariance’ which is in fact a basic linear model which combines both ANOVA and regression. It can be said that ANCOVA is similar to ANOVA, but in ANCOVA there is an addition of one or more covariates which may cause deviation in the value of Dependent variable or the DV. The function of ANCOVA is related to the breaking down of variance in the Dependent Variable into the variance of the covariates. The main use of ANCOVA is to increase the ability to find a significant difference between different groups while one already subsists.

ex: Do SAT scores differ for low-, middle-, and high-income students after controlling for single/dual parenting?

7.5 MANOVA

MANOVA means Multivariate analysis of variance (MANOVA). It is similar to an ANOVA, where statistical difference for one Dependent Variable is examined, but MANOVA is an extended version where multiple dependent variables are binded together to form a composite variable. In MANOVA, the difference between the vectors of means are tested. Due to the main disadvantage in ANOVA which is that it increases the experimental errors and it does not show any correlation between DV’s, MANOVA is therefore used. MANOVA does show a certain difference between the means

ex: 1. Whether a certain disease can be prevented or can be cured by either A-drug or B-drug.

2. Whether the pointers or scores of certain students in a school vary by their sections.

7.6 MANCOVA

MANCOVA means multivariate analysis of covariance. It is an extended version of ANOVA which covers areas where there are more than one dependent variables and where the complete use of covariates is necessary. The main advantage of the MANCOVA design over the basic MANOVA design is that it leaves out the error or fault caused due to the presence of the covariant. MANCOVA can be considered as an extension of MANOVA because of addition of one or more covariates that may reflect the value of the Dependent Variable.

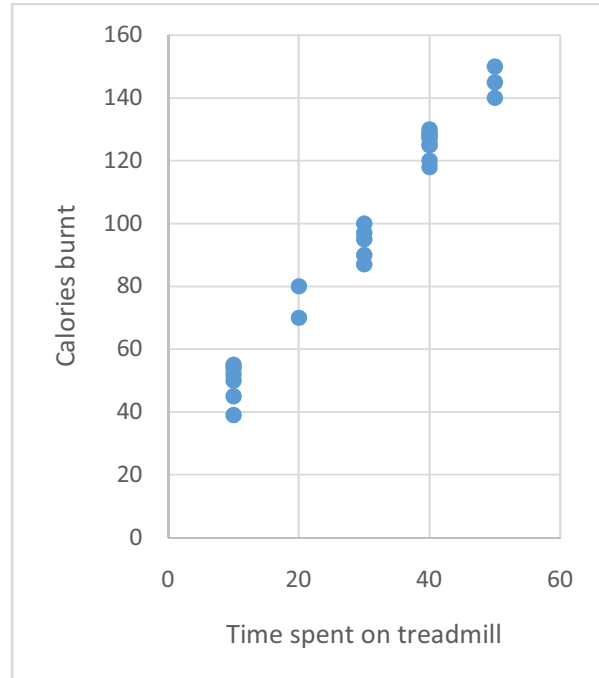
ex: Does ethnicity affect reading achievement, math achievement, and overall scholastic achievement among 6 graders after controlling for social class?

7.7 Correlation

It is used with two variables to determine a relationship/association. When we have continuous independent variable and a continuous dependent variable and we want to know if there is any linear relationship between them. The coefficient of correlation ranges from -1 to +1. When we get -1 it indicates perfect negative correlation and +1 indicates perfect positive correlation and 0 indicates there is no relationship. Familiar examples of dependent phenomena include the correlation between the physical statures of parents and their offspring, and the correlation between the demand for a product and its price.

- It does not distinguish between independent and dependent variables.

Eg- Whether there exists any relationship between the time a person runs on a treadmill, and the calories burnt by him.



The above scattered diagram shows that more you run on the treadmill the more are your calories burnt. It is a positive correlation.

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