# Economics of Hot Tapping

This article illustrates the importance of comparing hot tapping and shutdown methods to determine which is more cost-effective and fit for purpose for different applications. A cost-benefit analysis is a powerful tool that can be used to conduct a comparison of these two methods.

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# 1. INTRODUCTION

## 1.1 PIPELINE MAINTENANCE, UPGRADE AND REPAIR OPTIONS

Maintenance, emergency repairs, and upgrades form a significant part of any pipeline and plant operations. These include, inter alia [1]:

- Attaching a branch connection to the line
- Installing an internal probe or monitor
- To stop or redirect flow in a line for maintenance or repair purposes
- Positioning a branch fitting on an operating pressurized line, flowing or stagnant
- Removing defects, i.e., dents or pipeline damage

There are two main methods to conduct these routine and emergency procedures on pipelines; they are hot tapping and shutdowns. And each has its costs, benefits, and risks involved, requiring thought and investigation on the part of the owner to choose the most appropriate.

These two methods are briefly described as:

### Shutdown

A shutdown halts production in the pipelines temporarily to enable the safe execution of the work on a pipeline without it being live. While a shutdown allows the safe access needed to perform the needed maintenance and repairs, it has obvious cost implications with the loss of production throughput. Some of these associated costs with a shutdown are:

1. Loss of revenue (while the system is shutdown)
2. Maintaining compliance with national, state, and local regulations when shutting the system down is costly.
3. Potential costs of litigation and associated political ramifications are also a common concern and reality with system shutdowns.

### Hot Tapping & Line Stopping

Hot tapping, also known as line tapping, pressure tapping, pressure cutting, or side cutting [2], and line stopping method enables expansion and modification of pipe networks to be done under pressure without any interruption or stopping the network. Hot tapping is a common practice when specific parts of a pipeline network have been damaged or require modifications. Line stopping isolates certain parts of the pipeline network, which can support hot tapping services.

Hot tapping is a specialized procedure. Several factors need to be evaluated to determine if it is a feasible option before it can be considered a potential solution, including the condition of the pipeline, operation pressure, and pipe material. It is also essential to consider nearby emergency valves that can isolate the line, the working space around the connection, the location of other weld imperfections, and the tap diameter.

## 1.2 CONSIDERATIONS IN CHOOSING BETWEEN SHUTDOWN AND HOT TAPPING

There are various factors for stakeholders to consider when choosing to use hot tapping/line stopping or to perform a full shutdown. They include, among other things:

- Economic
- Environmental
- Access to skilled staff (how readily available are hot tapping skills to the client)
- Duration available for repairs
- Local by-laws
- Service Level Agreements
- Etc.

This article only deals with the economic portion of such a decision.

Because it is specialized, hot tapping can be expensive. It does, however, hold significant benefits, such as uninterrupted production and reduced emissions. It further reduces product losses, which can save additional costs for the company. [3]

The argument is often made that a standard shutdown procedure is less expensive and, therefore, more cost-effective than hot tapping. However, it is essential to look at the procedures holistically, not only the costs but also the benefits and losses involved with each.

A high-level comparison of the two methods is not sufficient. A more in-depth look at the economics involved with each is required to enable a fair comparison.

It is important to note that the economic drivers of such a choice are only a part of the decision-making process, as all other factors need to be considered.

## 1.3 THE ECONOMICS

### 1.3.1 PROJECT COSTING

To evaluate different cost estimations for a specific project, the best method to use is a cost-benefit analysis [5]. A cost-benefit analysis is a simple comparison of the estimated costs associated with a project or approach against the possible benefits of the project or approach.

When doing a cost estimation for a project, the costs can be divided into two main categories, direct and indirect costs. Direct costs are broadly classified as being directly associated with the cost of executing the project. In contrast, indirect costs cannot be allocated to a specific project but are shared across multiple projects, e.g., project management, quality control, etc. [4]

For the purpose of this article and staying with a simple project economics example, there is no consideration for indirect costs.

The direct costs can be broken down into the following subcategories [4]:

1. Labor
2. Materials
3. Equipment
4. Services
5. Facilities
6. Contingency Costs

More detail on techniques and methods of estimating costs on a project can be found here. Evaluation of hot tapping and shutdown procedures, use the above subcategories to calculate the cost of each.

### 1.3.2 HOT TAPPING COST BREAKDOWN

In order to do a cost-benefit analysis, the direct cost estimation for hot tapping needs to be completed. This is done at the start of a project and may often be a high-level cost estimation – depending on how much information is available at this stage. It is valuable to utilize previously completed project costings (if available) or to consult a hot tapping specialist to ensure realistic values are used and ensure a sufficient level of confidence is obtained in the evaluation.

Table 1 provides the cost breakdown for a typical hot tapping procedure.

TABLE 1: HOT TAPPING COST BREAKDOWN

| Item | Description | Cost Subcategories Included |
|---|---|---|
| Materials | Raw materials and consumables to complete the actual upgrade/repair work, such as a valve. | Material |
| Mechanical works (hot tapping, line stopping, welding, etc.) | Hot tapping equipment and service to perform the work. All welding, including the bypass line to gain access to an area that will be worked on. | Material, Labor Equipment, Service |
| Site Establishment and Transportation Costs | Infrastructure and offices, excavations, etc. required to be able to work in the area. | Facilities, Labor, Service |
| Pipeline Evaluations | Inspection and testing done on the pipeline before the repair can be done. | Service, Labor Equipment |
| Management | Project management and meetings required. | Service, Labor |
| Pre-Commissioning and Testing | Cold/Pre-commissioning and testing that need to be done before hot commissioning can be performed. | Service, Labor |
| Commissioning | Hot commissioning after work has been completed for final acceptance. | Service, Labor |
| Preliminary and General | Any ad-hoc costs involved in the project, upgrading schedules, fencing, additional security required at the site, etc. | Service, Facilities, Contingency |

The Mechanical works item includes the labor, material, and services involved in hot tapping. In some cases, it may be listed separately. For simplification in this article, it has been grouped together.

### 1.3.3 COST BENEFIT ANALYSIS

It is important to note that some costs are applicable to both hot tapping and shutdown philosophies. And so, the cost-benefit analysis can be simplified by excluding these costs. They typically are:

- Materials
- Site Establishment and Transportation Costs
- Management
- Preliminary and General

The Pre-Commissioning and Testing task could have higher costs associated with hot tapping operations than for shutdown due to additional testing required for the hot tapping equipment, if not performed at the service provider's cost. Similarly, additional costs can be incurred for pipeline evaluations, as hot tapping is highly dependent on the integrity of the pipeline. This is not only for the hot tapping location but also for the up and downstream sections of the pipe.

For commissioning, the hot tap operation could have a lower associated cost as a smaller section of the pipeline needs to be recommissioned. During a shutdown procedure, a large section of the pipeline may need to be recommissioned after the repairs/work have been done, which could incur additional time leading to increased production losses.

An additional cost that needs to be accounted for when conducting the cost-benefit analysis is a carbon tax, which has only recently been implemented in countries across the world. In some locations this could have no impact, and in others it could be substantial cost item. This is mostly relevant for a gas pipeline where a shutdown procedure results in large emission quantities due to gas venting. In some countries, this would result in additional tax penalties associated with the increase in emissions. The gas emissions during a hot tap are much lower than for a shutdown.

A significant factor that also needs to be accounted for is the impact of the procedure on production loss. This is only applicable to a shutdown where production is stopped during the process to allow the repair or upgrade to occur.

Another consideration is product loss. The type of product determines cost significance. This is relevant for both a shutdown and a hot tap since the section of the line under construction needs to be emptied before work can be done. The amount of product emptied for a hot tap is significantly less than for shutdown. A liquid product can, in most cases, be recovered and reintroduced into the system. This is, typically, not possible for a gas which is vented to the atmosphere. In addition, for gas products, purging is required, which adds an additional cost to the procedure, more so for the shutdown than for hot tapping. [3]

Two approaches can be used to account for the loss of production and product;

a) the losses can either be included as additional costs for the shutdown procedure, or
b) it can be listed as a benefit of the hot tapping procedure.

It is, however, important that this cost/benefit is not accounted for twice.

Even though this article attempts to discuss a general procedure, individual operators are advised to consider company records and consult a hot tapping specialist when doing a cost-benefit analysis. Each pipeline and system are unique and may have additional factors that need to be accounted for.

## 2. LINE REPAIR CASE STUDY

The best way to illustrate how to conduct a cost-benefit analysis is by means of a simple example. The case study below describes a simplified and theoretical case in which either hot tapping or a shutdown could have been employed to repair a defect in a liquid pipeline. Costs that would differ based on the type of product (liquid vs. gas) are also highlighted.

Note that no real-world case will ever be this simple. The purpose it to illustrate the philosophy at play in determining the most suitable method for pipeline repair work.

### 2.1 BACKGROUND

Company A is a gasoline supplier that operates a 30-mile gasoline pipeline between two cities. During routine pipeline inspections, a defect was detected in the 8" pipeline that needs to be repaired to prevent a leak and contamination of the surrounding area. A 15 ft section of pipe needs to be replaced. The pipeline section was evaluated, and it was confirmed that only the 15 ft section needs to be replaced and that the surrounding pipeline's condition and process parameters are suitable to enable hot tapping to be used for the repair.

Company A is evaluating the most cost-effective method to repair the defect. They want to compare the cost of conducting the repairs through a shutdown or by making use of hot tapping/ line-stopping, which would typically be outsourced to an engineering or hot tapping contractor. The evaluation used the following process parameters and specifications:

The items outlined in Section 1.2 are used to calculate the cost of repairing the pipeline. Typically, a company would request a quote from a hot tapping specialist to perform the hot taps and line-stopping. In addition to the hot tapping and line stopping, the specialist will typically also procure and supply all the required material required to perform the work unless the company prefers to procure the material internally.

The following process was followed to conduct the cost analysis.

1. Calculate the cost of hot tapping
2. Calculate cost of complete shutdown
3. Calculate production cost
4. Calculate loss of product (if relevant)
5. Compare costs and benefits between hot tapping and shutdown.

The following assumptions were made:

- No product loss as the liquid product is recovered for both hot tapping and shutdown.
- Costs similar for hot tapping and shutdown which were excluded:

- Materials
- Site Establishment and Transportation Costs
- Management
- Preliminary and General

### 2.1.1 HOT TAPPING COST

Depending on the contractual agreement, either Company A or the hot tap specialist will develop a bill of quantities (BOQ) to determine the cost of materials required. The specialist will also be able to provide a line item in the quotation indicating the cost of the hot tapping and line stopping works. The costs that were identified to be similar for both hot tapping and shutdown are not included in the cost analysis. The calculated costs are given in Table 1.

The mechanical works are the highest contributing item (92% of the total) to the cost of hot tapping, mainly due to the equipment and the labor costs.

TABLE 1: SUMMARY OF HOT TAPPING COSTS

| Item | Description | Final Cost | Contribution (%) |
|---|---|---|---|
| A | Mechanical works (hot tapping and line stopping) | $ 483 277 | 92 |
| B | Pipeline Evaluations | $ 6 600 | 1 |
| C | Pre-Commissioning and Testing | $ 19 800 | 4 |
| D | Commissioning | $ 13 200 | 3 |
| **Total Cost Excluding VAT** | | **$ 522 877** | **100** |

### 2.1.2 COMPLETE SHUTDOWN COST

The cost of a shutdown procedure is given in Table 2. Similar to the hot tapping, the mechanical work contributes the most to the cost, but in this case, it is only 52%. For a shutdown, the costs are more evenly spread across the different categories.

TABLE 2: SUMMARY OF SHUTDOWN COSTS

| Item | Description | Final Cost | Contribution (%) |
|---|---|---|---|
| A | Mechanical works including labour and consumables of a shutdown | $ 41 500 | 52 |
| B | Pipeline Evaluations | $ 6 600 | 8 |
| C | Pre-Commissioning and Testing | $ 17 820 | 22 |
| D | Commissioning | $ 14 520 | 18 |
| **Total Cost Excluding VAT** | | **$ 80 440** | **100** |

## 2.2 COST BENEFIT ANALYSIS

The cost-benefit comparison is comprised of two parts. Firstly, the actual cost difference between the two procedures. Secondly, the loss of production is evaluated for both procedures. For this evaluation, we assume a price of $2 /gallon.

Production is halted for the shutdown procedure. Depending on the work required, this typically ranges from 5 – 10 days, but can and will vary outside of that range depending on other cases. Figure 1 shows the financial impact of production loss over a period of 1 to 10 days. For this specific example, a linear relationship was assumed between production and shutdown periods.

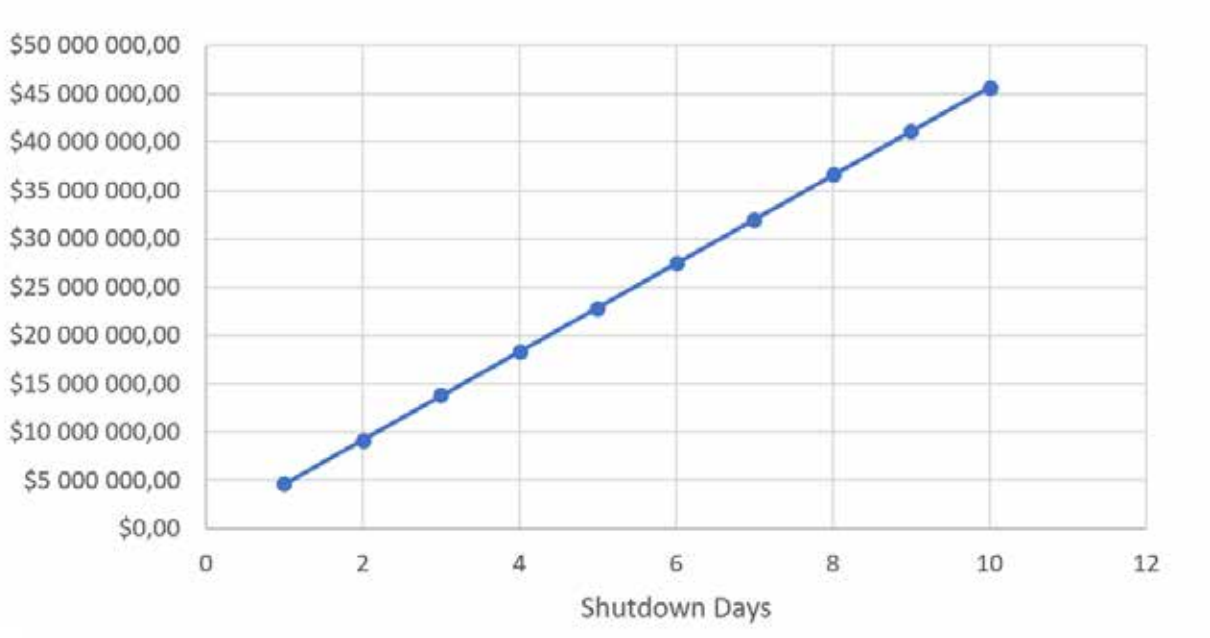


FIGURE 1: GASOLINE PRODUCTION LOSS OVER TIME

Table 3 provides a summary of the cost of hot tapping versus a shutdown procedure. Comparing only the cost of the two procedures clearly shows that a shutdown procedure is much cheaper than hot tapping. However, the complete cost of a shutdown, taking into consideration the high production loss, clearly indicates that hot tapping is the most cost-effective method.

TABLE 3: COST COMPARISON SUMMARY

| Item | Hot Tapping | Shutdown |
|---|---|---|
| Cost | $ 522 877.00 | $ 80 440.00 |
| Production* | $ - | $ 22 824 000.00 |
| **Total** | **$ 522 877.00** | **$ 22 904 440.00** |

*5 days production

## 3. CONCLUSION

Pipeline upgrades, maintenance, and emergency repairs are all critical aspects that need to be planned for and executed on a regular basis. These can lead to a loss in production due to shutdown procedures and has a significant financial impact. Any approach that allows for the minimization of these losses needs to be thoroughly evaluated and investigated.

Hot tapping and line-stopping offers an approach that potentially offers large cost savings, compared to shutdowns.

When comparing the costs associated with a traditional shutdown approach, it often appears as if a shutdown is more cost-effective, as it involves procuring hot tapping specialists which can seem costly. However, when comparing the cost and benefits of a hot tap procedure with a shutdown, the loss in production overshadows the higher cost of the hot tapping—clearly showing that most often hot tapping is more cost-efficient.

In the event of gas lines, the loss of the product adds an additional layer of cost to the shutdown procedure, as the product can often not be recovered. As mentioned, another additional cost that is becoming more significant is the added tax on carbon emissions, which can be limited due to the lowered environmental impact of hot tapping. This is particularly relevant to companies that frequently require repairs or upgrades over a longer period of time, which results in significantly higher emissions.

This article illustrates the importance of comparing these two methods to determine which is more cost-effective and fit for purpose for different applications. A cost-benefit analysis is a powerful tool that can be used to conduct a comparison of these two methods

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