

Justification for Maintenance and Reliability Readiness

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The ability to articulate a persuasive business case for building and implementing a top-tier, sustainable Maintenance and Reliability (also known as Operational) Readiness program (hereafter referred to as M&RR program) is fast becoming a necessary talent for the project managers leading capital projects and the reliability department heads advising them. This is because a business case is almost always a prerequisite for C-suite executives who recommend such investments for approval to the firm’s board of directors.

This paper discusses a framework for evaluating the M&RR program benefits for the Greenfield new capital assets business case. More specifically, it illustrates how failing to design and install a top-tier M&RR program leads to an approximately 9% (or \$90 million per \$1 billion invested) loss of value to the project over its first five years of operation. Converted to an annualized rate of return, this roughly equates to a 2% per year reduction in the project’s value.

In the Management Resources Group Inc. (MRG) article Capital Projects Operational Readiness and Risk Risks (Bruno Storino, 2012), an M&RR program is defined as a concerted plan to address operational risks from the early stages of project execution, develop mitigation activities, and prepare new projects to be efficiently operated and deliver optimal performance.¹ The overview in Figure 1 shows the elements or modules of the MRG M&RR program. Using a modular approach, the program is designed to be flexible, take advantage of existing procedures, and add knowledge to match specific requirements. Activities are selected from the comprehensive framework and customized to project-specific needs.

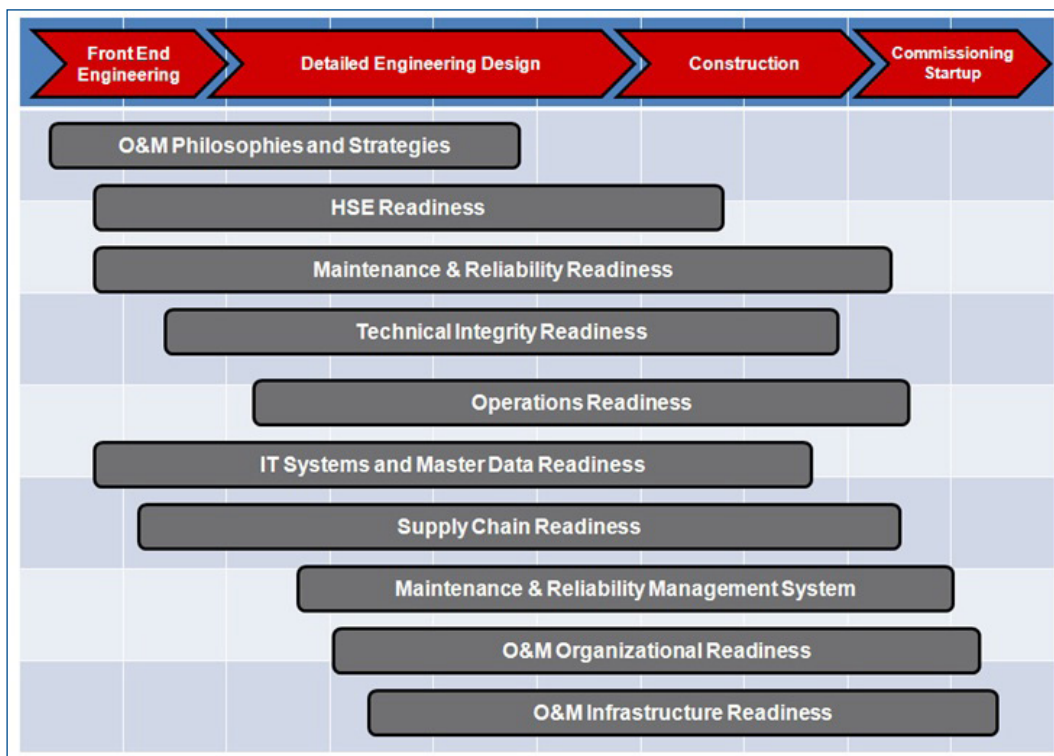


Figure 1 — Comprehensive Maintenance and Reliability / Operational Readiness Plan.

There is no doubt that the ascendancy of Operational Excellence has helped drive the pursuit for more uptime, lower downtime costs, and more efficient use of company resources. Firms in both the private and public sectors of the Canadian, and indeed the global, economy are increasingly focusing their attention on the reliability of physical assets to perform the tasks for which they were purchased and installed. In addition, capital markets, debt rating services, and financial advisors are placing a premium (all other things being equal) on the stock of companies that can consistently achieve their production targets. To a significant degree, top-tier asset reliability has become a proxy for a higher probability of predictable cash flow. Given that many C-suite executive compensation packages are structured to include stock options, asset reliability is fundamentally aligned to the corporate decision making process.

The focus on Maintenance and Reliability Readiness has further been reinforced by the release of the first edition of the ISO55000 Asset Management standard earlier this year and the impending release of the API 691 Risk-based Machinery Management best practice, which focuses not only on understanding and mitigating risks posed by rotating equipment throughout its life, but also on documenting and maintaining records for this machinery.

For Greenfield capital projects, the best approach to building in Maintenance and Reliability Readiness is to start early in the project-planning phase. This helps ensure the project has the best chance of meeting its production targets, which tend to assume a smooth 12-month ramp-up period after commissioning. In addition, it is often less difficult (it's never easy) to get M&RR program funding during the CAPEX project phase. Once the plant has started up and has a profit target to meet, Operations often is focused on cutting costs, not on funding new initiatives. Funding the M&RR program during the CAPEX phase is also more financially efficient, as it enables the cost to be depreciated over the life of the asset instead of it being charged to Operation's P&L as an expense.

Perhaps the most powerful rationale is that it is a very cost-effective way to ensure top-tier performance.

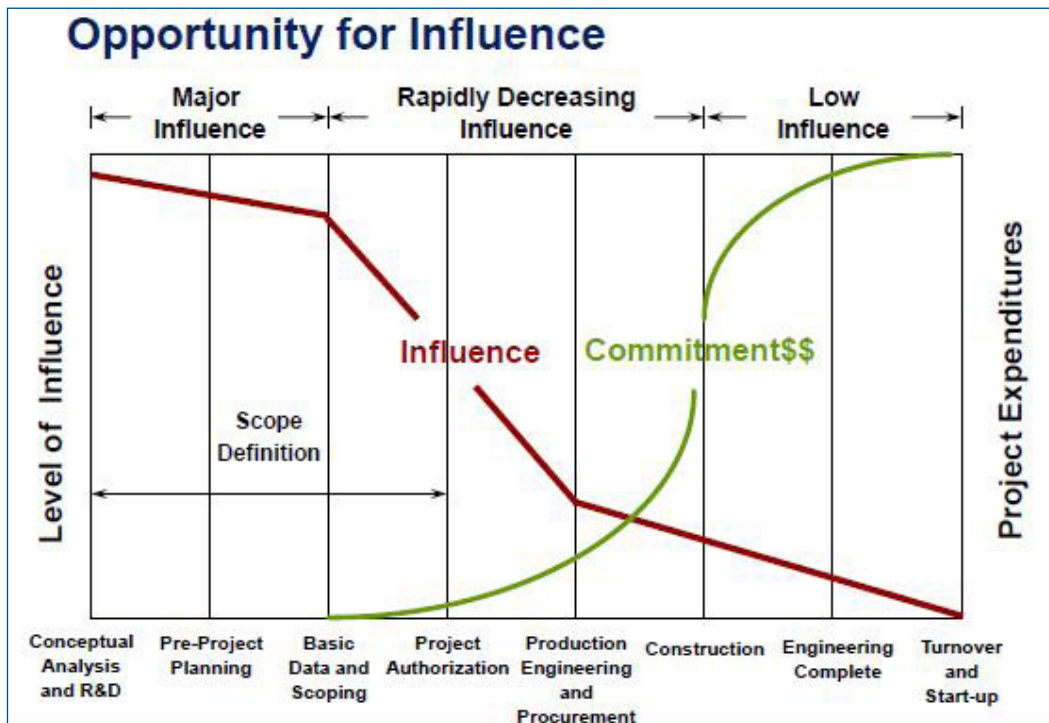


Figure 2 – Influence and Expenditures at Stages of the Project Lifecycle.

As illustrated in Figure 2, taken from the Construction Industry Institute, the ability to influence a project (i.e. asset configuration, production capabilities, etc.) decreases markedly as the project progresses.² In fact, expenditures and the cost of delaying decisions or making changes increase dramatically as the project progresses. The optimum point to best influence the final project for the lowest cost is during the very early stages of scope definition. As a general rule of thumb, every dollar needed to mitigate a risk during Conceptual Design Engineering or PRE-Feed will turn into \$10,000 if not identified until Turnover and Start-up.

As expanded upon in the Uptime article Bridging the Gap (DiStefano et al, 2012), the primary reason that comprehensive M&RR programming hasn't yet been incorporated into mainstream engineering practice is largely cultural—this has not been the way projects are executed.³ The good news is that this mentality is changing fast. Senior leadership at many Fortune 500 companies has begun to budget for the design, development, and implementation of a top-tier, sustainable Maintenance and Reliability Readiness program.

While it may be generally understood and acknowledged that building and implementing a top-tier, sustainable M&RR program during the early stages of a capital project (i.e., before commissioning and start-up) is an excellent goal, the realities of business demand that such recommendations be justified with a business case and some quantifiable value. Decision makers want to see what the positive impact of early implementation can be or, conversely, what the loss of value to the project may be if it is not done.

Before delving into the concept of the business case in greater detail, let's review some key concepts involved in building the framework for the Maintenance and Reliability Readiness business case.

Capital Budgeting: Capital budgeting is the process that describes how a firm allocates its capital resources between competing projects and investments. Today, virtually all firms use a form of discounted cash flow analysis such as net present value (NPV) or internal rate of return (IRR) in capital budgeting analysis. The capital budgeting process requires estimating the size and timing of all the incremental cash flows from the project and incorporating a discount (hurdle) rate that reduces the future value of each successive cash flow value.

Hurdle Rate: The firm's hurdle rate, in simple terms, is the minimum rate of return on a project that a firm requires, given its risk profile and the opportunity cost of other investments. The riskier the project, the higher the hurdle rate.

The investment hurdle rate for energy companies tends to be around 10% according to Andrew Leach, Enbridge professor of Energy Policy at the University of Alberta.⁴ This value is not far from the findings of research done by prominent U.S. economists on 127 industrial firms. They found that the average real hurdle rate (nominal rate less inflation rate) is around 12%.⁵

To illustrate, if a Canadian company had a hurdle rate of 12%, it would most likely accept a project with an internal rate of return of 15%, particularly if it is using a proven technology in a country where the firm currently operates successfully. An example is an Oil and Gas company expanding its heavy oil production by building its fourth 35,000 bbl/day SAGD plant in the Athabasca Oil Sands. In comparison, if a Canadian manufacturing firm created a brand new product and is planning to sell this product through its distribution network into the United States when it has only been operating for the last three years, it may choose to factor in a risk premium and raise the hurdle rate from 12% to 16% to account for the perceived elevated risk related to selling a brand new product with no track record.

Internal Rate of Return (IRR): A project's internal rate of return is the effective discount rate that makes the net present value of all cash flows from a particular project equal zero. In other words, it is the effective yield of the project or investment. An IRR is often used by corporations that wish to compare capital projects. For example, a corporation will evaluate an investment in a new plant versus an extension of an existing plant based on the IRR of each project. In such a case, each new capital project must produce an IRR that is higher than the company's hurdle rate. Once this hurdle is surpassed, the project with the highest IRR would be the wiser investment, assuming all other factors are equal (including risk).

Net Present Value (NPV): The NPV is defined as the sum of the present values of the cash flows of the project or investment over a defined time horizon.

Returning to our scenario above, if the firm was to discount the future cash flows of that project (which was actually yielding an IRR of 15%) by the hurdle rate of 12%, it would result in a large and positive net present value, which would likely also lead to the project's acceptance. While the results of this analysis may give the company the confidence to move ahead, it's important to note that the margin between the project being considered a success or a failure is fairly small—just 3% in the example.

The Greenfield Business Case

The benefits to be gained, or the loss of value to be avoided, by investing in a top-tier M&RR program are significant. However, in the case of a Greenfield investment, it is often difficult to quantify the benefits because there is no comparable plant (i.e., similar design capacity and operating parameters) in the company from which to derive baseline maintenance and reliability performance metrics. In such circumstances, it is advisable to reference industry-specific (e.g., Petro-Chemical, Automotive, Pulp & Paper, Pharmaceuticals, etc.) benchmarks such as Maintenance Spend as a % of Replacement Asset Value (Maint. \$ / %RAV) and MRO Inventory as a % of Replacement Asset Value (MRO \$ / % RAV) for the business case.

Let's first establish the context for the analysis. In our example, let's assume our new SAGD capital investment, called GreenCo, has the following characteristics:

Capital Cost*	\$1 Billion
Maintainable assets	15,000 MRSI (Maintenance & Reliability Significant Items)
Production	35,000 BBL/Day oil
Oil price (per BBL)	\$80
Life of Plant	30 years
No M&RR program	Top 3rd quartile (i.e. ~ 50% percentile) performance
With M&RR program	Middle 1st quartile performance
Hurdle Rate	12%
Change in Maint. \$ / %RAV	2.00% better with M&RR program
Change in New Spares \$ / % RAV	1.00% better with M&RR program

* In this example, Capital Cost equals Replacement Asset Value (RAV). RAV is defined as the cost that would be incurred to replace the facility and equipment in its current configuration based on current replacement prices. It is intended to represent the realistic value to replace the existing assets at new value. See the list of inclusions and exclusions below for more details.

INCLUSIONS	EXCLUSIONS
<ul style="list-style-type: none"> ■ Building envelope ■ All physical assets (equipment) that must be maintained on an ongoing basis ■ The value of improvements to grounds (provided these must be maintained on an ongoing basis) ■ Capitalized engineering costs 	<ul style="list-style-type: none"> ■ Value of land on which the facility is situated ■ The value of working capital ■ Raw material, work-in-process, and finished goods inventory ■ Spare parts inventory ■ Capitalized interest ■ Pre-operational expense ■ Investments included in construction of the facility that are not part of the facility assets ■ Mine development ■ Mineral rights and land lease costs

This paper uses the median (essentially the 50% percentile) set of M&R benchmark metrics to represent the performance of the SAGD plant without a top-tier M&RR program. While it could be argued this level is either too conservative or too aggressive, in the absence of a comparable plant, it provides a reasonable starting data point from which the top-tier M&RR program's benefits can be evaluated.

What was not stated in the section on capital budgeting, but all too often is true, is that for a specific investment to generate an IRR greater than the hurdle rate, Operations leadership and C-suite executives base the revenue (and hence production) projections on both a smooth 12-month ramp-up (or break-in) period and the ability to consistently either meet or come close to the plant's nameplate production capacity. This is an extremely important assumption, as there cannot be an asymmetry of production and calibre of M&RR program designed and implemented. In other words, to achieve top-tier performance, the plant must follow a set of M&RR best practices. For example, top performers deploy a variety of Predictive Maintenance (PdM) and condition monitoring technologies on the majority of the candidate equipment population and use less time-based, invasive preventive maintenance (PM)—typically less than 25% of the equipment population is covered by time-based invasive PM.

Stated plainly, if a Greenfield plant's business case is based on the mid-first quartile availability and reliability (i.e., consistently achieving production targets), it requires a well-designed M&RR program with implementation starting in the project-planning phase.

Using a set of defined and stated assumptions, we have conservatively calculated that failing to design and install a top-tier M&RR program at the start of a new capital project can lead to at least a 9% (or \$90 million per \$1 billion invested) loss of value over its first five years of operation. Converted to an annualized rate, this roughly equates to a 2% per year reduction in the project's rate of return.

Now how did we come up with the \$90 million loss in value?

Major Benefits of a Greenfield M&RR Program

Listed below are some of the major benefit categories with guidance on how to calculate the potential plus a project savings value for GreenCo when adopting a top-tier M&RR program:

- **Maintenance Spend Reduction:** Calculate your maintenance spend as a percentage of Replacement Asset Value (RAV), and dollarize the improvement. The benefit comes from eliminating unnecessary work, working more efficiently, reducing the need for abundant stocked spares, eliminating collateral damage thereby reducing use of spare parts, reducing use of contractors, reducing overtime, etc. MRC's proprietary benchmarking statistics of the difference between mid-first quartile and top-third quartile indicate improvement in the range of 2.5% – 4% can be expected.

GreenCo project savings: We conservatively estimate savings of at least 2%, or \$20 million, to the maintenance budget each year.

- **New Spares Inventory Reductions:** Calculate your stocked inventory value of spares required for the first two years of normal operations as a percent of RAV, and dollarize the improvement (approximately 0.5% - 1.5% of RAV). This is a one-time benefit. In addition, the recurring annual avoided inventory carrying costs, warehouse facility expenses, labor costs, etc., will be on average 25% of the full inventory reduction value annually. Note that neither includes any write-off/down of inventory.

GreenCo project savings: We estimate one-time savings of at least 1%, or \$10 million, to the maintenance budget each year and on-going savings of \$2.5 million.

- **Improved production during the ramp-up phase:** A recent study by Deloitte determined that about 60% of the loss of production in the first 12 months of a plant's operation (the ramp-up phase) is due to reliability related problems, such as equipment failures.⁶ The remaining 40% was due to external factors that Operations does not focus on controlling, such as political risk, market price fluctuations, and product demand.

GreenCo project savings – if we assume that a mid-first quartile plant would produce 5% more oil than a top third-quartile plant during the first year ramp-up, and if we conservatively take the value loss of not having the extra revenue (due to deferred production), it is worth approximately \$2.5M, based on a 5% interest rate.

Improved production = 35,000 BBL/D x 365 days x 5% x \$80 = \$51.1M @ 5% ≈ \$2.5M / yr

The remaining three types of benefit categories, for the purposes of this GreenCo SAGD business case, are identified but do not have Greenfield M&RR project savings included. Following discussions with senior leadership, the company may decide to add some or all of them into the equation as well.

- **Energy Consumption Reduction:** Published guidelines show that smoother running rotating equipment and leak-free operation of water, steam, and compressed gas handling equipment will consume from 3% to 14% less energy (i.e., electricity, fuel).
- **Increased Uptime:** Increased Asset Utilization can have a variety of substantial financial benefits to a company, including selling more product created by the existing capital assets (assuming the demand for the additional product is present) or reducing the cost of goods made on the capital assets through more stable operations (even if the demand for additional product is not present). Two downtime areas should be targeted: Unscheduled Maintenance-related Downtime and Scheduled Maintenance Downtime. Unscheduled Maintenance-related Downtime can eventually be almost eliminated. Scheduled Maintenance Downtime in a plant heavily dependent on time-based Preventive Maintenance strategies can be reduced by between 30% and 60% (depending on the starting point). Dollarizing the value of this varies from business to business; however, these benefits can be three to seven times larger than the maintenance spend reduction.
- **Improved Quality:** Typically, scrap material and rejected/returned off-spec product is measured accurately in most corporations. Calculate the value of the scrap material and assume that between 5% and 16% of that value can be eliminated through sound reliability practices. In addition, calculate the value of the rejected/returned product and assume that between 1% and 5% of that value can be eliminated through sound reliability practices. These statistics will vary from business to business.

Putting It All Together

The actual investment calculation where the hurdle rate is used to discount future cash flow values back to today is really quite straightforward. The challenging part, as may be obvious by now, is in quantifying the various benefit categories.

The analysis in Figure 3 shows that the M&RR program for the GreenCo SAGD project will generate \$95.38 million in additional benefits over the first five years of the project's operations—the aggregate of NPV values for years one to five. (Note that this value would be substantially higher if the benefit reduction categories of energy consumption reduction, increased uptime, and improved quality were quantified and included.)

While there is no doubt this sizeable \$95 million NPV value would support considerable M&RR program investment, the critical question is how much does the company need to invest in the GreenCo M&RR program to obtain these benefits?

Fortunately, a recent Suncor study of a similarly sized (~ 15,000 MRSI) SAGD project provides some guidance. In Foundation for M&R Excellence – Success and Challenges (Ramakrishnan et al, 2013), the authors estimate 36,000 man-hours were invested.⁷ Using an average cost per hour of \$175, this equates to a labor investment of \$6.3 million.

M&RR Category	Cash Flows by Year (\$ Million)					
	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Benefits						
Maintenance Spend		\$20	\$20	\$20	\$20	\$20
New Spares Reduction		\$12.5	\$2.5	\$2.5	\$2.5	\$2.5
Deferred Production		\$2.5	\$2.5	\$2.5	\$2.5	\$2.5
Energy Consumption		-	-	-	-	-
Increased Uptime		-	-	-	-	-
Improved Quality		-	-	-	-	-
Costs						
M&RR Program Costs	(\$6.30)					
Subtotal	(\$6.30)	\$35	\$25	\$25	\$25	\$25
Discount Factor (12%)	1.00	.88	.774	.681	.60	.528
Annual NPV Value	(\$6.30)	\$30.80	\$19.35	\$17.03	\$15.00	\$13.20
NPV (5 years)	\$89.08					

Figure 3 – Example 5 year NPV for a Top-Tier M&RR Program.

For simplicity, if we assume the full \$6.3 million is spent before production begins (i.e., in year 0), then the five-year NPV of the GreenCo M&RR program is \$89.08 million. Expressed another way, each \$1 invested in the M&RR program returned over \$15 in benefits.

While the example shown above provides a general framework for calculating the financial business case for a top-tier Maintenance and Reliability Readiness Program, recognize that other key capital planning parameters, such as the effects of taxes and exchange rates, haven’t been factored into this spreadsheet. However, by going through and listing each benefit and cost category, you will have taken a crucial step in creating the required input data for your finance department to run the numbers on the request for M&RR program funding.

Summary

A concerted Maintenance & Reliability Readiness program identifies operational risks, organizes actions to mitigate those risks, and prepares new assets to be efficiently and safely operated. With more C-suite executives than ever committing to fund the integration of a top-tier M&RR program into their new capital projects, it is incumbent on Maintenance and Reliability practitioners to understand their firm's capital budgeting process.

We know that you can't piecemeal your way to prosperity. Top performers attack the opportunity holistically, weaving all of the aspects of a top-level M&RR program carefully together early in the engineering cycle to unlock the hidden benefits. We also know the direct benefits will come from maintenance spend reduction, new capital spares inventory reduction, reduced energy consumption, improved quality, reduced scrap, and increased throughput/asset utilization.

By investing in a comprehensive M&RR program early in the project planning phase, our SAGD example showed that the company stands to earn at least a 15:1 return on its money and ensures that the investment hurdle rate of return is reached, therefore qualifying the GreenCo project as a success.

With a solid understanding of the direct benefits and how an M&RR investment is typically justified, you're well on your way to making the business case!

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