The Good, the Bad and the Ugly – The Importance of Management of Change in Building Siting

Kris Smith
Risktec Solutions, Inc.
16055 Space Center Blvd, Houston, TX 77062
Kris.Smith@risktec.tuv.com

Jayant Kulkarni
Risktec Solutions, Inc.
15810 Park Ten Blvd, Houston, TX 77084
Jayant.Kulkarni@risktec.tuv.com

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Kris Smith
Risktec Solutions, Inc.
16055 Space Center Blvd, Houston, TX 77062
Kris.Smith@risktec.tuv.com

Jayant Kulkarni
Risktec Solutions

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Abstract

According to the Occupational Safety and Health Administration's (OSHA) Process Safety Management (PSM) standard, Management of Change (MOC) is required by companies when any changes (e.g. equipment, procedures, staffing or buildings) are made to facilities containing highly hazardous and reactive chemicals. Several incident investigations conducted by the Chemical Safety Board (CSB) over recent years have identified that the root causes of catastrophic accidents usually include some element of improper or ineffective change management. Although many companies have mature MOC programs, there is still some uncertainty as to the effectiveness of their processes.

1 Introduction

Siting studies are required under OSHA's regulation, *Process Safety Management of Highly Hazardous and Reactive Chemicals.* The analysis is mandated, but the way in which the analysis is conducted and the way in which results of the study are managed are up to each company. Over many years of conducting siting studies while working for operating companies and since becoming consultants, we have had many opportunities to learn from what went well and what didn't. This paper focuses on five key lessons we've learned over the years and how to make sure the industry is better equipped to deal with siting issues in the future.

2 Lessons Learned from 20+ Years of Conducting Siting Studies

2.1 Siting is more than buildings and occupants

While most companies perform siting studies to comply with OSHA's PSM regulation and thus API RP-752, 753 and 756, siting goes well beyond just buildings and its occupants. Smart companies consider siting from a broader perspective and use information generated during a siting study to not only address buildings and occupants, but to also identify the best location for new units, new equipment, new support structures, potential offsite impact and future use. This requires that siting is considered during the early stages of a project. While most MOC programs capture the addition of new temporary or permanent buildings or the relocation of personnel, a true MOC program should consider factors associated with the location of any change.

For example, whilst installing a new atmospheric storage tank may or may not impact the results of an existing facility siting study, it can definitely exacerbate existing problems related to runoff, containment, smoke and emergency response. These should all be thoughtfully considered during the initial design to ensure runoff is to the safest location, containment isn't overloaded and smoke and firewater are manageable from an emergency response standpoint.

For new green field projects, a preliminary facility siting study should be done early in the select phase. This allows the location of process equipment, utilities and support buildings to be conscientiously chosen to provide the greatest distance possible between hazards and personnel for likely credible scenarios for fire, explosion and toxic or reactive releases. Many midstream companies are employing this approach when siting new plants. By reviewing siting issues early enough in the design phase, companies can build-in areas for future expansions and projects. In order to produce an early stage siting assessment, one would need a preliminary plant layout in 2D and some basic process data in order to determine the impacts of the new proposed facility.

For brown field and existing units, this becomes trickier because of the possible significant layout and materials already present in the facility, however it is still an extremely valuable analysis. Adding a train to an existing facility can be analyzed simply by identifying the location on the plot plan and using the data from the existing or similar available train to develop likely explosion overpressures, radiation levels and toxic release concentrations. These can be overlaid on the new unit's plot plan to determine if it exacerbates any existing facility siting issues or creates any new issues. This information can then be used to fine-tune the layout to provide optimum placement for preventing or mitigating explosion, fire and toxic/reactive release scenarios. Once the plot layout is finalized and the design is set, the existing siting study can be updated to include the new analysis generated by the change.

Companies considering adding whole new units to their complex can still conduct preliminary siting studies by using results from similar type units to estimate the impact to the site. For example, adding a new polymerization unit to an existing petrochemical complex can be evaluated using data from like facilities. If the company has existing polymerization units in other locations or the contractor conducting the study has experience with similar polymerization units, information gleaned from those units can be used to help site future units in the complex. Conducting a preliminary siting study using similar process information will help the company determine if adding the unit is feasible or if the risk of placing a new unit inside an existing complex is too high.

2.2 Risk-based siting gives you greater control

PSM requires that facilities covered under 29 CFR1019.119 conduct a facility siting analysis. By definition these facilities process flammable, explosive, toxic or reactive chemicals. Consequently, a release of any of these chemicals may have dire consequences. When addressing siting issues, the key is to prevent loss of containment. If chemicals remain contained within the process, then the facility, its staff and surrounding communities are safe.

Over the years, many companies have spent millions of dollars designing new buildings and relocating personnel. This is usually a result of a consequence-based facility siting study which will almost always tell you that buildings or people are too close to the process. This approach overlooks the fact that risk is comprised of both consequences and their likelihood. The worst case consequence used in the study for example is likely to occur very infrequently.

The most effective way of preventing undesirable consequences is by keeping hazardous chemicals in the "pipe." It is all about better design, strictly controlled operations, competent personnel and routine, predictive and preventive maintenance. Money spent on quality and reliability improvements not only results in better profitability, but also reduces the likelihood of loss of containment events.

Relocating personnel reduces the potential for fatalities should a loss of containment occur. It does not, however, reduce the frequency of a loss of containment event. The event still has the same likelihood of occurrence. If you are not only concerned about the people but also the asset, then resources should be focused on ensuring loss of containment events don't occur. MOC allows you the opportunity to do that. The purpose of the MOC program is then to, little by little, change by change, incrementally reduce the overall risk by improving performance and reliability.

2.3 Use the "best tool" for the analysis

There are several ways to conduct siting studies and many documents currently exist which discuss appropriate methods (e.g. Ref. 1, 2, 3, 4, 5 and 6). As a result, there are many "tools" in the market to assess siting and many experienced practitioners capable of applying these tools to conduct the analysis. The key to a good, cost-effective siting study, however, is to know when to use which tool.

A qualitative evaluation is a good first-step. It allows you to cost-effectively screen out buildings and situations that are of no or very little risk. Items that cannot be screened out require further thought and more in-depth analysis. In these situations, quantitative tools may be more appropriate. Siting studies can range in costs between a few thousand dollars to several hundred thousand dollars depending on the size of the facility, extent of quantification and level of detail. So, it is important to understand what each tool accomplishes and when it's time to use a different tool.

For example, it doesn't take a sophisticated computational model to determine that a concrete building built in the 1960s and sitting in the middle of a process unit is not the safest location for your operations personnel. Tools are available to calculate the probable overpressures at the building as well as its structural capability to withstand an explosion. Those analyses cost money and take time. A better approach for managing this situation is to look for opportunities to relocate

control operations to a more remote location and, in the meantime, focus on the mechanical integrity of equipment in the nearby area. Perhaps the money might be better spent replacing old equipment, improving seal systems or adding detection and mitigation systems rather than calculating something that will only tell you what you already know. Again, this can be accomplished through the MOC system. Each time you make a change, evaluate what might be done to lower the risk or remove the hazard. This will build inherently safer systems while addressing existing risk issues.

As with all analyses, the more sophisticated the tool, the more complex and expensive the study. Starting with a qualitative approach allows you to use your money wisely, only using the sophisticated tools to evaluate the more difficult issues and, instead, spending money on actual prevention measures.

2.4 If you decommission it, it should go

Removing unused equipment and piping reduces risk. The energy released in an explosion is significantly higher if the release and ignition occur in confined or congested spaces. Therefore, as part of each change, consider "cleaning house."

If the change involves replacing equipment or adding equipment, consider how that effects the confinement and congestion of the area. Where possible, leave adequate space to prevent escalation or reduce the consequences of an explosion.

2.5 The siting report is not just a report

Companies have invested hundreds of thousands of dollars over the years conducting siting studies only to find out, after a short period of time, that the results are obsolete. Siting studies should be evergreen and should be considered process safety information. Individuals within the company who are responsible for the study should also be educated on what to do with the results of the study.

Frequently, progress on siting issues is hindered by personnel changes. Today, almost every company has performed siting studies, yet in many cases the facility risk remains unchanged because nothing was done with the results due to key people moving on or being assigned different priorities. Actions generated as part of a siting study should be managed the same way as actions generated by process hazards analyses, incident investigations and audits. People newly assigned to address these actions need to understand what the report is saying. Changes to processes need to be evaluated against the siting study as they may impact the results.

The only way to do this is to ensure the assumptions made during the study and the input data used for the study are preserved. To do this, companies should always retain this information in-house, which means asking consultants to provide this data along with their deliverables (make sure the contract requires all native files to be handed over). And then, companies need to ensure the report findings are translated into actionable and understandable recommendations which are tracked until closure.

Frequently, the people who understand the physics and chemistry involved in releases, fires and explosions are not the ones who need to fix the problem. It is in the best interest of the company

that the information provided in the study can be understood and addressed by the workforce. This may involve providing additional education to key employees, working more closely with the analysts or asking more from those who conduct the study.

3 The Good, the Bad and the Ugly Examples

The following are examples of some good, bad and ugly practices we have seen over the years.

3.1. ***The Good***

3.1.1. High Level Siting Assessment of New Units

Siting a process unit using a screening risk assessment makes good business sense. Issues around the layout of the new unit, its location within the site and existing and proposed buildings can be assessed without specific information on process flows, pressures and temperatures by using analyses from similar process units. Using experience developed over several years of performing siting studies for all different types of facilities, from oil and gas to petrochemical, to chemical manufacturers, a screening method can be developed to determine optimum design layouts.

For example, Company A planned to expand their existing operation using some of their available plant space. Assessing the impact of this new unit on their existing facility site helped identify that an existing Warehouse was vulnerable to projected blast overpressures. This allowed decisions to be made relative to the location of the existing warehouse and layout of the site's plot plan thus, reducing the risk to people housed in the Warehouse.

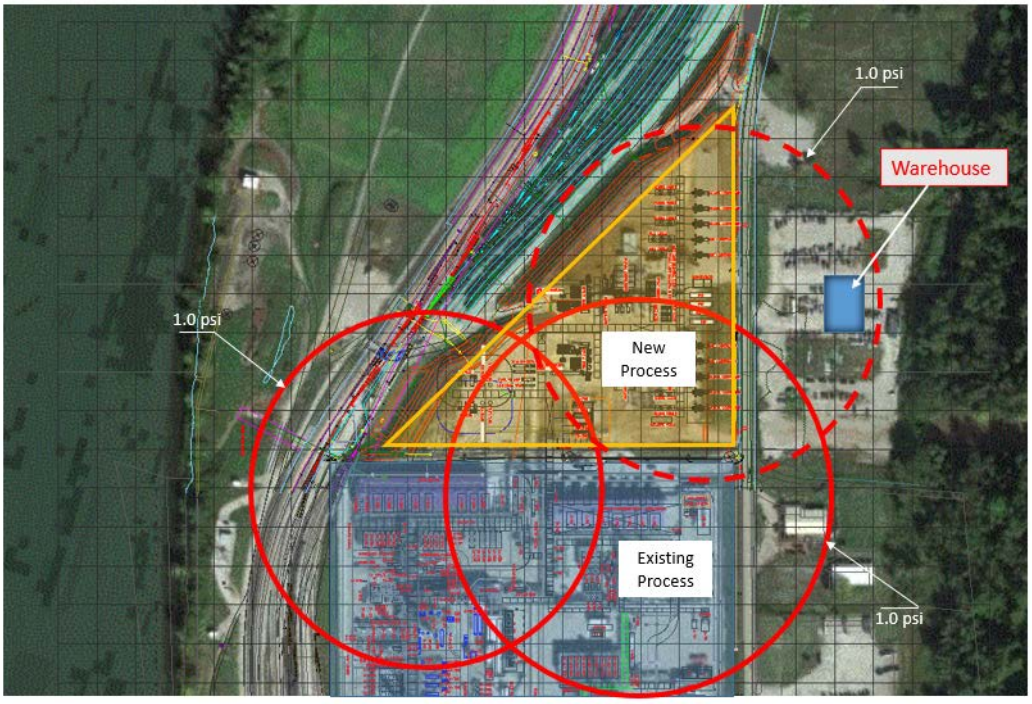

Figure 1: Selection of New Unit Location

This example shows that companies considering adding whole new units to their facility can still conduct a high level siting assessment by using results from similar type units to estimate the overall impact to the site.

Another example of using a screening method involved Company B who had plans to add a green field facility to their portfolio. Based on the screening method, it was determined that the proposed layout had an undesirable effect on the proposed control room that would require significant modifications, either structural or relocation. A small change to the layout was made while it was still in design which reduced the risk profile at the site at a fraction of the cost of structural upgrades.

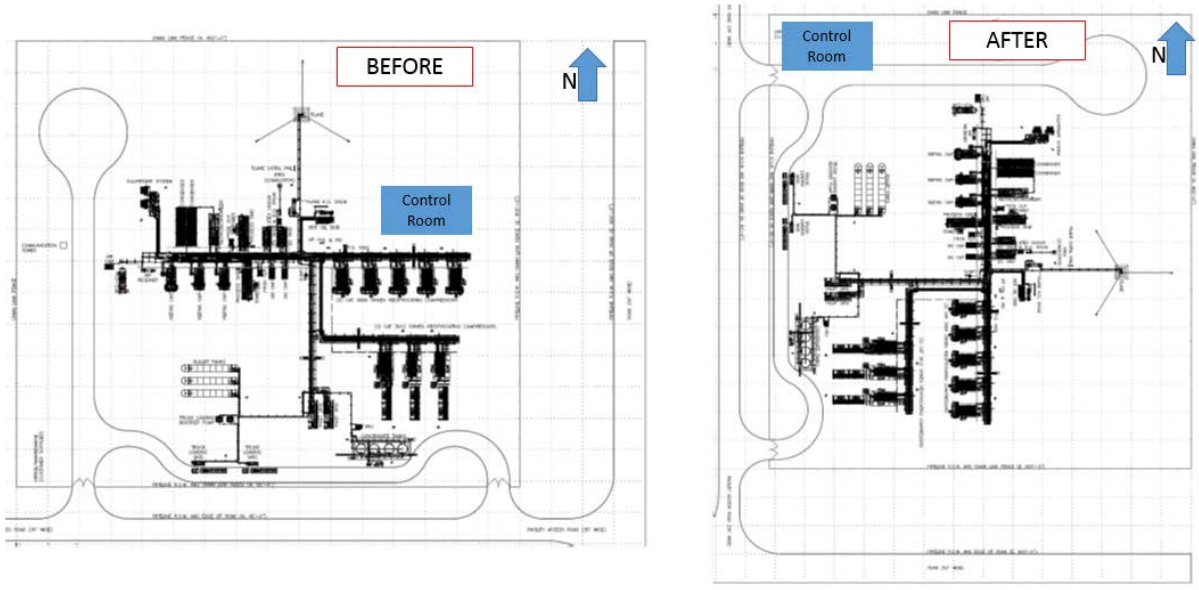

Figure 2: New Layout Before and After Siting Assessment

This early intervention allowed the location of process equipment, utilities and support buildings to be conscientiously chosen to provide the greatest distance possible between hazards and personnel for likely credible scenarios for fire, explosion and toxic or reactive releases. By reviewing siting issues early enough in the design phase, companies can build-in areas for future expansions and projects.

3.1.2. Changes to personnel

Management of personnel changes should also require an evaluation of the potential impact to the facility siting study. For example, Company C planned to reduce the number of operators due to budget cuts. Reducing the number of operators could impact the inspection frequency of equipment, training and competency of operators and response time to alarms which could lead to more frequent catastrophic events. However, Company C utilized a management of personnel change process which required a hazard analysis involving all concerned department representatives. In their analysis, these items were identified and appropriate safeguards, including reconsidering some staffing levels, were put in place to maintain the current risk level.

Personnel changes can have a profound impact to frequency of events and therefore, the risk associated with siting. It is as important to include an evaluation of the impact to risk from changes to personnel as it is to changes to equipment and processes.

Figure 3: Facility Siting Authorized Personnel

3.1.3. Decommissioning

Decommissioned units, although not active, still pose a risk for overpressure if its equipment and structures remain onsite as explosion overpressures increase with confinement and congestion.

Company D was interested in building a new administration building near an abandoned unit. Performing a qualitative evaluation showed that by keeping the equipment in the decommissioned unit, the results from an explosion analysis would be unacceptable or cost-prohibitive. Once Company D considered removing the unused equipment, it was determined that the proposed location for the new administration building was within acceptable limits.

3.2 The Bad

The following are some examples of some bad and some down-right ugly situations resulting from either a lack of awareness or a general disregard of facility siting principles.

3.2.1. Structural modifications over time

Client E listed the building on their Siting Assessment as a Blast Resistant Building. Over time, an air intake vent was added after the building was located onsite. The manufacturer of the

building provided documentation to support their claim. In the documentation, the manufacturer explicitly stated that any modifications to the building would require re-analysis to ensure the building maintained its blast resistance. This was not done at the time the vent was contemplated.

As part of a facility siting revalidation (required every 5 years per OSHA's PSM regulation), it was determined that the structural integrity of the building was lost when the vent was added and that the retrofit would need to be evaluated. Additionally, it was also noted during the revalidation that the building allowed egress from only one location, making it a concern with regard to escape and evacuation due to fire or toxic release. Ultimately, the building will require relocation or retrofit to address these risks – a costly mistake.

Figure 4: Building Integrity

Company F expanded their plant over time without considering the siting impact of the changes. Some of the major issues found during revalidation were:

- New hazards were added to the facility which had the ability to impact the Control Room;
- The Control Room was originally a blast rated building; however, over the years several modifications were made to the building to accommodate a new distributed control system and air conditioning. Both modifications affected the structural integrity of the building and it could no longer be considered blast rated;
- Pipe racks containing toxic materials were added above the building presenting a new hazard not previously considered. The building was not equipped with a toxic chemical detection system or an automated HVAC shutoff system.

Thus, the risk to personnel inside the building had significantly increased over time.

Figure 6: Control Room Revalidation

3.2.2. Siting portable buildings during turnaround.

In preparation for an upcoming turnaround, Company G required the addition of several light-wood portable trailers to house contractors during the maintenance activity. Company G placed the trailers outside the fence line as it was considered to be outside the process area and thus not at risk from explosion, fire or toxic releases. Unfortunately, explosions, fires and releases aren't stopped by fencing. Their location was within the potential blast overpressures and the contractors were at a higher risk due to the location of the trailers.

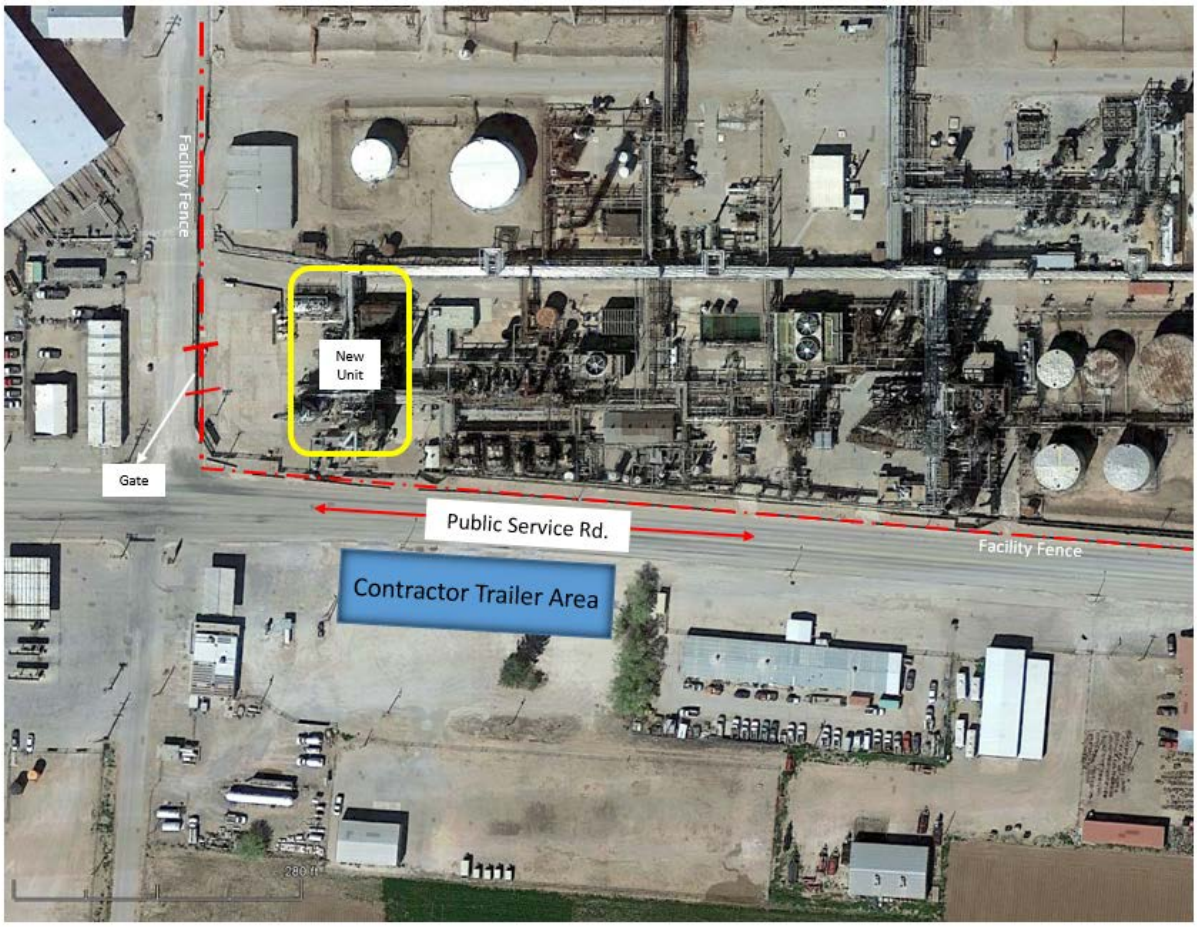

Figure 5: Siting Portable Buildings during Turn around

3.2.3. Acquisitions and facility siting

As part of due diligence for new acquisitions, it is appropriate and prudent to evaluate the findings from the other company's siting study before making final decisions. Costs for addressing facility siting issues can escalate into the millions if relocation and rebuilding are required.

For example, Client H purchased assets from another company. Client H's facility siting standard was based on consequences only and had resulted in relocation and rebuilding of many facility buildings over time. Their new acquisition had used a risk-based approach to facility siting and had managed risk by relocating non-essential personnel and improving reliability. In order to meet the acquiring company's acceptance criteria, a lot of capital investment would be necessary. Had facility siting been part of the due diligence process, decisions on the acquisition may have changed or at least been considered during the negotiations.

4 Conclusions

Conducting qualitative or quantitative siting studies when considering capital improvements allows you to make better informed decisions on layout and siting of new equipment or facilities. A preliminary siting study can be performed with limited information using similar units as the basis for the analysis.

Using the MOC process to encourage the use of inherently safer technologies is a cost-effective way to reduce risk and address legacy siting issues. Ensuring the chemical remains in the "pipe" reduces the likelihood of a catastrophic event and reduces the risk of siting-related fatalities.

Expect more from the siting experts. Use their knowledge to educate your workforce. Use their results to guide your decisions. Use the report as input to future changes. Manage the siting report as you would any key piece of process safety information and treat the recommendations as you would any other process safety study.

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