# Contractor Safety Prequalification

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**Abstract**
This safety-procurement tradeoff can be addressed by setting safety standards and then exempting selected activities and/or contractors. Or this tradeoff can be balanced by an informal or formal best-value point system that weighs, in each case, the relative value of contractor safety capabilities against contractor price and quality offerings. Construction work is particularly difficult to safety prequalify because the ramp-up time to bidding is short; construction uses several layers of subcontracting; and the formation of subcontracting teams comes late in the bidding process. Furthermore, the number of potential subcontractors that need to be prequalified explodes as the layers of subcontracting deepen. This means that the ratio of those who must be prequalified to those who are actually selected rises with every new layer of subcontracting thus raising prequalification costs. The solution to this dilemma is very-large-scale third party prequalification so that whole segments of the construction industry are prequalified for a wide range of hosts.

# Contractor Safety Prequalification

## Current Practices and Prospective Models

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# Introduction

A novice traveled far to meet the wise man.  Upon arrival, the youth asked the venerable teacher: "Master, upon what does the Earth stand?"  And the wise man said: "The Earth stands upon an elephant."  To that the young man asked: "Master, upon what does the elephant stand?"  And the teacher said: "The elephant stands upon a turtle."  Not yet satisfied, the seeker asked: "And Master, upon what does the turtle stand?"  Annoyed at this bothersome youth, the Master scowled: "It's turtles all the way down."

Globalization has transformed the world economy through outsourcing and insourcing so that we, like that raw youth, might wonder, where exactly did this product I hold in my hand come from?  Who made it?  Ask the wise economist and the teacher might say:  "Well the product came from this branded company."  But where did the branded company get it?  "The branded company got it from an offshore supplier."  But where did the offshore supplier get it?  "The offshore supplier got it from a subcontractor."  And where did the subcontractor get it?  Now it is the economist's turn to scowl: "It's subcontractors all the way down."

The fog of subcontracted supply chains has got American consumers worried.  An example is the consumers of Melissa & Doug children's toys.  In response to a worried parent's email about lead paint, Melissa & Doug replied:

> Please be assured, we test for lead VERY frequently.
>
> It's quite possible to make great quality children's items in China, which meet all safety regulations, but the key point is that you have to test and inspect very frequently to be sure that your factories are always following your instructions explicitly. We assure you that's exactly what we do.

From our experience, the key to doing this correctly is not simply to insist that your factories follow your instructions, but then to go one step further and to AUDIT, INSPECT, AND TEST very frequently. That is the most important part of the process, and it's something our company has always taken VERY seriously.[1]

The fog and uncertainty surrounding outsourcing is one side of the coin of global complexity. On the other side is insourcing. Insourcing is where a host employer invites contractors to come onto the host's worksite to perform tasks the host would rather contract-to-others than self-perform. Sometimes the host does this because the task at hand is very specialized and the host's workers are not trained to do this work. Sometimes the task is menial and a contractor can bring onsite lower-paid employees to do the work at a lower cost. Sometimes the work is periodic. Perhaps the plant needs to be shut down for routine maintenance or the installation of new equipment. Specialized firms may have emerged in the market that go from host-company to host-company taking care of their periodic requirements leaving the host workers to meet the day-to-day needs of the host's operations. Quite often, host companies bring onto their worksite construction contractors to expand or refurbish the host's facilities. Almost equally as often, hosts will bring to the worksite maintenance contractors who will simply maintain some aspect of the host's facility.

In the US context, contract workers divide into two types—temporary workers coming from temp agencies and the employees of contractors who have obtained work on the site. Temporary contract workers are directly supervised by the host. True contract workers are supervised by their own contractors. This is a key difference. The host has the direct responsibility to direct, manage and insure the safe work activities of temporary

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[1] http://www.diaperswappers.com/forum/showthread.php?p=2129240 (accessed December 26, 2007)

workers.  On the other hand, contractors direct, manage and supervise the work of their employees including insuring that their employees work safely.  This creates a degree of separation between the host management and the safety practices of contract workers on their site.  Host employers can <u>manage</u> the safety of temporary workers, but host employers need to <u>buy</u> the safety of contract workers through their choosing to purchase the services of one contractor as opposed to another.

Whatever the reason that drives host employers to bring onto their worksite outside contractors, the presence of one or many contractors on a host's worksite adds complexity to the operation due to the multiplication of managements and crews working together or along side each other.  This complexity multiplies when the contractor brings along with him subcontractors to take a piece of the work the contractor does not wish to self-perform.

Complex systems can be economically efficient, driving costs down and placing just the right specialties in just the right jobs and/or by bringing less expensive workers onto the site.  But complex systems can also break down.  When there is a slipup, the quality of the process or the product can be compromised and workers can get hurt.  In worst case scenarios, catastrophes can occur that kill workers, destroy property and damage the reputation of the host employer.

In the spirit of an-ounce-of-prevention-is-worth-a-pound-of-cure, host employers increasingly are prequalifying their contractors before they get onto the worksite. Contractor prequalification usually is a three-legged stool where the good contractor will stand on firm financial ground, have a reputation for quality work, and be a safe

contractor.  Insuring any of these qualities in advance is challenging.  How and when hosts try to make sure that the contractor will work safely is the subject of this report.

In one sense, the host company using insourced contractors on a multiemployer worksite is faced with the same problem as the toy company with a bunch of outsourced suppliers.  The toy company gives firm instructions to its supplies and then AUDITS, INSPECTS AND TESTS.  These are basically the same tools available to the host employer in dealing with insourced contractors.  But the toy company audits, inspects and tests companies that are already in their supply chain.  In safety prequalifying contractors, host employers must audit, inspect and test not only contractors that they have hired, but also contractors that they might hire which of course will also include many contractors that they will never hire.  So pre-qualification can be very expensive compared to post-qualification.  The reason host employers engage in prequalification is because after-the-fact examination of contractor safety practices may, in some cases, be too late.

There are several possible solutions to the potential expense of prequalification. **First**, you can carve out work that inherently poses little risk of accident and exempt it from safety prequalification.  This is very common.  **Second**, you can limit pre-qualification to very basic safety standards that are inexpensive to assess saving more detailed examination for either 1) the contractors that actually bid on your work, and/or 2) the contactor that provisionally has won your work.  This layered approach to safety prequalification is also common particularly in the UK.  **Third**, you can cooperate with other host employers, effectively spreading the costs of safety prequalification of contractors that you jointly use.  This might be done informally through sharing of

information about contractor history, performance and capabilities with other host employers.  Or hosts may formally join local area safety councils that safety prequalify contractors within a local market, usually in a particular industry.  Or hosts can hire third-party contractor safety prequalification services that prequalify contractors for multiple hosts in multiple areas and in multiple industries.  Whatever the form of host cooperation, these strategies are designed to address the expense of contractor safety prequalification by exploiting the economies of scale associated with spreading the cost of safety prequalification across more work.

Whether the host uses the carve-out approach, the layered approach, the economies-of-scale approach or any combination of the three, the problem remains— what selection criteria should be applied in order to separate the safe contractor from the unsafe contractor?  Currently, hosts have used some combination of the principles of safety engineering and past experience to design their safety criteria.  We will argue that these approaches can be supplemented by creating feedback loops within safety prequalification itself that identifies what selection criteria are working.

In assessing the safety prospects of a contractor, two basic criteria are applied: what has been the past safety history of the contractor?  And what are the current safety capabilities of the contractor?  The first looks at safety outcomes in terms of injuries, worker-compensation experience modification rates, governmental safety inspections and fines, fatalities, property damage, large events and catastrophes.  The second looks at best safety practices as determined by safety engineering and safety management guidelines. A question always exists on how to balance past performance versus current capacity in trying to predict future safety performance.

Because the cost of safety prequalification is ever present, hosts, when examining the past safety performance of contractors, have tended to focus upon injury rates and worker compensation rates and other readily available data gathered by third parties. In this report, we will argue that the process of contractor safety prequalification, itself, when tracked over time, can be an additional source of relatively inexpensive information about contractor safety performance and an additional source of information on how to establish efficient and effective contractor selection criteria. These data have the virtue of not only being able to create more customized measures on past performance compared to government collected data, but more to the point, over time data emerging from the contractor safety prequalification process, itself, will be able to track the past safety capabilities of contractors. Having three pieces to the puzzle in the same data set—past safety performance, present safety capabilities and past safety capabilities—prequalification data will begin to give us a clearer answer to the question of how to balance past performance against present capabilities in projecting future safety outcomes.

What is needed is the creation of information feedback loops that connect the process of prequalification to worksite safety outcomes and then back once again to the process of safety prequalification. Because there are strong economic incentives for hosts to cooperate in contractor safety prequalification, these informational loops can encompass much more work than is on offer from any one host employer. That means these loops of information spanning host companies can provide a wealth of information regarding what works, and who works well.

Contractor safety prequalification is a quasi-Darwinian process of economic selection which has two benefits. In the short run, effective safety prequalification ensures that the contractors on the host site are relatively better managers of workplace safety. In the long run, contractor safety prequalification may serve as a stimulus for the adoption of best safety practices across the entire contractor community. In the short run, safety prequalification may raise bidding costs by restricting the number of bidders available to the host. This bid-price cost may be offset in the short run by avoiding the costs of accidents. However, in the long run, the cost of safer work may decline as best practices diffuse across the contractor community and the pool of available safe contractors is refilled. Contractor safety prequalification when widely applied creates a dynamic of the survival of the safest contractors.

However, it remains to be seen how hosts will end up cooperating with each other in contractor safety prequalification thus defining and diffusing safety selection criteria. The US market currently provides a range of prequalification solutions with area safety councils and safety prequalification service providers approaching the problem differently. Different approaches are partially a response to different needs and circumstances among the host employers.

Safety prequalification is easier to implement in activities where the contractor is onsite for longer periods of time doing more work with fewer subcontractors. Periodically returning contractors are easier to safety prequalify compared to short-term, one-shot contractors. It is harder to screen out contractors based on safety criteria when the contractor is the only one who can do the work or when the work is an emergency job that has to be done now. Sometimes economies of scale can be found in safety

prequalifying the pool of workers the contractor uses along-side safety prequalifying the contractors, themselves. Other times, economies of scale can be exploited by safety prequalifying the one-shot contractor through a third party because, after all, the contractor who is one-shot for you is nonetheless regularly in business and not a one-shot contractor for the market as a whole. Various types of third-party safety prequalification companies are competing with each other currently by trying to find the methods and techniques that will best exploit possible economies of scale and scope. Nonetheless, this is a young industry and considerable future innovation and perhaps merging can be expected from these third parties.

Regulations can help in creating and capturing economies of scale in contractor safety prequalification. Governmental regulations can identify what kind of work cannot be exempted from contractor safety prequalification setting a general standard. Governmental regulations can generally establish an understanding of what needs to be done. Sometimes safety prequalification is reduced to simply assuring that the contractor is in compliance with government safety regulations. But safety prequalifications need not and probably should not be limited to government-established safety standards. In this report, we argue that ultimately the proof is in the pudding. Safety prequalification standards, themselves, measured against contractor safety outcomes should be the source of determining what works in selecting contractors. These standards can come from government safety research, private research or company experience. Establishing the information flows needed to determine what has worked is the main task standing before hosts who are currently engaging in contractor safety prequalification and the third party service companies that serve the host-contractor community.

Keeping in mind all the assistance, help and encouragement that we have received from all the aforementioned sources, nonetheless, the conclusions and opinions expressed in this report are those of the authors and do not necessarily reflect the opinions of the University of Utah, our employer, or ORC-Worldwide and Duke Energy Foundation, our sponsors, or the many safety prequalification participants, regulators and observers without whose cooperation this research would not have been possible.

# Executive Summary

We begin our report with a review of the literature on contractor safety prequalification and end with two chapters summarizing two surveys we did for this report. In this executive summary, we focus on the key results of our research found in chapters two through five.

## Chapter 1: Selected Literature Review

The literature review 1) traces the growing interest in safety prequalification in terms of changes in industrial organization and industrial relations, and 2) situates safety pre-qualification within aspects of the occupational health and safety model from the literature, highlighting features of that model that appear to be most amenable to modification by the practice of safety prequalification, and the circumstances under which that modification may have the most impact.

The review situates the growing interest in safety prequalification in the growth of contingent labor, and the attendant issues of liability that arose with it over the past thirty years. Particular focus is given to the early prominence of the safety issues surrounding contract workers in the petrochemical industry, and to the in depth analysis of the John Gray Institute Report after the Phillips 66 Houston Complex accident in 1989. The review also briefly analyzes the use of contract labor and consideration of pre-qualification in the public sector, with specific focus on the Department of Energy. The review also briefly reviews insights from economic theory, particularly the industrial organization literature regarding the underlying motivations for safety prequalification, and from the theory regarding information problems.

After a short review of a case study in the prequalification industry, a large prequalification service provider in the UK, the review focuses on aspects of contract work in the petrochemical industry from the literature that is most likely to compromise safety.   In both sections, one clear conclusion follows: safety pre-qualification can be used as part of a strategy to reduce the liability concerns that have hindered promotion of safety in the labor relations in the host-contractor relationship.   But, to be effective, it largely needs to be integrated as part of a larger strategy that encourages the extension of an effective safety culture of the host firm to contract workers.   This culture includes risk accurate risk assessment, appropriate training, ongoing management that encourages contractor and employee participation, and ongoing supervision over hazards on the job.

## Chapter 2: An Analysis of the Effectiveness of Current Safety and Health Prequalification Practices

Contractor safety prequalification is designed to match the contractor's safety expectations and capabilities to that of the host employer.  Safety prequalification is also a market signal designed to set, and over time, raise the standards of contractor safety performance on multiemployer worksites.  Contractor safety prequalification combined with a risk assessment of the work to be let also provides a measure of the gap between what the host needs and what the contractor can provide.  This allows the host to fill in the gap either through direct action or by placing additional requirements upon the contractor.

Contractor safety prequalification comes in two basic varieties—plant or company go-it-alone approaches and cross-plant or cross-company multi-host-employer approaches.  The advantage of the solitary approach is that selection criteria and

inspection procedures can be fit closely to the exact needs of the plant site or the overall host company. The advantage of the multi-host approach is the ability to spread the costs of prequalification across more work.

Multi-host approaches include informal cooperation, area safety councils and safety prequalification service providers. The local area safety councils typically combine contractor safety prequalification with worker safety prequalification. Workers may be drug tested or skills tested. Criminal background checks can be performed. If there is a close overlap between the community of contractors a set of hosts uses and the community of workers that the contractors use, economies of scale and scope can lower the overall costs of doing both these types of safety prequalification. However, for the most part, local area safety councils are dependent upon a geographical concentration of similar host companies creating the contractor/labor-pool overlap. Third party safety prequalification service providers while often historically rooted in particular industries, nonetheless, in principle and in practice tend to be more diversified geographically and in terms of the industries they serve.

Because contractor safety prequalification necessarily rejects some contractors as unsafe, it systematically confronts a tradeoff against procurement needs which, all other things being equal, would prefer the widest array of potential bidders. The safety–procurement tradeoff is key to understanding the level of rigor in contractor safety prequalification. Our surveys show that, on average, about 14% of contractors failed safety prequalification. Our survey analysis showed that contractors were less likely to fail if they were on the host's worksite for less than six months. This reflects the prequalification-procurement tradeoff in two ways. First, some short-term contractors are

not so integrated into the host's work process as to be exposed to significant risks. One example of this is the "maintenance" contractor who came periodically but briefly to replace the tires on the host's vehicles. Second, the cost of prequalifying closely and deeply short-term contractors is high for the time they will be on site. So hosts may not set as high a standard below which contractors fail in the case of short term contractors compared to long term contractors.

This safety-procurement tradeoff can be addressed by setting safety standards and then exempting selected activities and/or contractors. Or this tradeoff can be balanced by an informal or formal best-value point system that weighs, in each case, the relative value of contractor safety capabilities against contractor price and quality offerings. The former approach may provide a stronger market signal stimulating an improvement in the safety capabilities of the entire contractor community over the long run.

Construction work is particularly difficult to safety prequalify because the ramp-up time to bidding is short; construction uses several layers of subcontracting; and the formation of subcontracting teams comes late in the bidding process. Furthermore, the number of potential subcontractors that need to be prequalified explodes as the layers of subcontracting deepen. This means that the ratio of those who must be prequalified to those who are actually selected rises with every new layer of subcontracting thus raising prequalification costs. The solution to this dilemma is very-large-scale third party prequalification so that whole segments of the construction industry are prequalified for a wide range of hosts. This occurs in the UK where safety prequalification is mandatory while at the same time it is layered. Third party service providers provide a first cut in the prequalification process. A second more detailed layer is applied to those who

actually bid on the job plus their subcontractors and a third again more detailed

"qualification" process is applied to those provisionally selected. Widespread and

layered safety prequalification is one way to address the potentially high costs of safety

prequalifying construction contractors.


## Chapter 3: An Analysis of the Critical Attributes that When Incorporated into Prequalification Standards Are Most likely to Enhance the Safety Performance of Contractors

In an analysis of contractors' past performance predicting current safety outcomes

using data from PICS, a service provider company, we found that past lost workday

injury rates strongly and tightly predicted current lost workday injury rates. However,

the relationship was not one-to-one. In the simplest test, if one contractor in the past had

double the lost workday injury rate of another (i.e. 100% higher), then today, that more

dangerous contractor would have an 87% higher injury rate. So the past is prologue, but

contractors also learn from their past mistakes. Thus, there is a role for assessing

contractor current capacity as well.

In a multiple regression analysis of 114 contractors, we found that the seriousness

of past injuries played a role in how much contractors reformed their ways. Double the

average number of days lost per lost workday injury case in the past, and other things

being equal, the contractor's lost workday injury rate today will be 7% lower.

Furthermore, double the number of safety prequalification requirements asked for by the

host employer and the contractor's current lost workday injury rate will fall by 16%.

These data indicate that current contractor safety capacity is important because

contractors learn from past mistakes, especially serious mistakes. But also, contractors learn from the safety standards imposed by hosts with the result that the contractor's operations are safer. With more and better data from more thoroughly established information loops, this sort of analysis could be expanded and refined to precisely identify which safety criteria had the greatest effect on contractor safety performance. (For instance, we tested the effect of the number of past fatalities on current lost workday injury rate finding that each additional past fatality lowered the contractor's current lost workday injury rate by 7%. But fatalities are rare events and a larger sample is needed to give a more precise idea of how past fatalities reform the ways of contractors).

We found some evidence indicating that contractors self-selected in safety prequalification processes based on their past safety performance. We compared contractors who completed the first stages of the prequalification process with those who failed to provide all the required information. We found that those who did not complete the process tended to have poorer past safety records compared to those who went through the process.

We asked the question: which was a better predictor of the current lost workday injury rate—past lost workday injuries or past experience modification rates (EMR) drawn from the workers compensation insurance system. While both positively predicted current injuries, the past lost workday injury rate was a tighter, stronger predictor of current lost workday injuries compared to past EMR rates. However, there is really no need to choose. A multiple regression model including both factors tested on the history of 373 contractors showed that both predictors had independent value in predicting current contractor safety outcomes and can be used together to help screen contractors.

(Rule of thumb—double the past EMR rate between two contractors and you will have increased by about 55% the predicted current lost workday injury rate of the contractor with the higher EMR rate. Double the past lost workday injury rate and you will have increased by about 86% the predicted current lost workday injury rate. Double both, and the predicted injury rate is the sum of the two—141% higher.)

In terms of various measures of current safety capacity (based on a multiple regression analysis of 526 contractors), if the contractor has a behavior-based safety program, all other things being equal, lower the contractor's predicted lost workday injury rate by about 64%. Similarly, if the contractor has a company safety director, compared to those who do not, lower the predicted injury rate by 72%. If the contractor has a site safety representative, compared to those who do not, lower the predicted lost workday injury rate by 44%. Return to work policies, light duty policies and accompaniment to medical treatment policies do not statistically significantly affect lost workday injury rates in our sample. Doctor accompaniment policies do seem to reduce minor injury reports. Contractors with these policies have a 43% lower restricted duty injury rate.

What about the relative importance of past safety history versus current safety capabilities? In a multiple regression model covering 370 contractors that was basically a horse race between past outcomes versus current capacity, past outcomes came in first and second with current capacity coming in third and "out of the money." In this model, double the past lost workday injury rate and the more dangerous contractor would have an 83% higher current injury rate. Double the past EMR rate, and the more dangerous contractor would have a 54% higher injury rate. If the contractor added a company safety

director, notch the contractor's predicted injury rate back down 23%. Add a behavioral-based safety program to all this and you might be able to drop the predicted lost workday injury rate by another 5%. But you could not be sure because this last result was not statistically significant. Conclusion? Contractors that added a company safety director after having safety troubles in the past were doing something to address the problem. Adding a behavioral based safety program, by itself, did not seem to do much once you controlled for whether in the past the contractor had been safe or not. Once again, these kinds of results will become more detailed and more robust as the feedback loops in contractor safety prequalification become wider and deeper with larger samples, and more varied and detailed contractor selection criteria.

## Chapter 4: A Model of Contractor Safety Prequalification

Any model of contractor safety prequalification must begin by addressing the safety-procurement tradeoff. We found that as the percent of the host's onsite work that was done by contractors increased, the number of safety prequalified bidders on the host's bid list increased. This makes sense. The more reliant you are on contracted work, the more it pays to develop and maintain a longer list of safety prequalified contractors to draw from. But we also found that if the host was reliant upon large contractors to do onsite work, the host's bid list would be shorter. This too makes sense. There are a lot of small contractors out there and not nearly as many large contractors. If the host needs large contractors, the host will be forced to have a short list of contractors capable of doing this type of work. However, this is not the problem it appears. Drawing on other work we have done, we point out that competitive bidding is not merely a

function of the number of contractors bidding on a job. It is also a function of how valuable the work is—in economic jargon, it is a function of the opportunity cost to the contractor of not winning the work. If the contractors really want the work, they will bid hard even if only a few other contractors are bidding on the job. Large amounts of work are less common than smaller jobs and worth more to contractors. So hosts reliant upon large contractors may also find large contractors are reliant upon them for the work. In addressing the safety-procurement tradeoff, hosts need competitive bidding and maintaining longer bid lists is one way of insuring that. Shorter bid lists may work as well, if the work is of sufficient value as to get the qualified contractors' attention. In general, we found that 1) the more the host uses contractors onsite, the more often the host encounters problems with restrictive bidding, 2) the longer the host's bid list, the less often restricted bidding is a problem, 3) the more contractors are on-the-job only short periods of time, the more restricted bidding becomes a problem and controlling for all these factors, 4) the more the host's contractors are construction contractors, the more restricted bidding is a problem. Because we have already controlled in the model for short time on site, we interpret this last result as reflecting the subcontracting layers typical of construction creating a restricted bidding problem for safety prequalification.

So a model of safety prequalification must address restricted bidding problems. One way to do this is through various cross-host cooperative schemes of contractor prequalification. Informal cooperation and especially local safety councils and safety prequalification service providers will lengthen the list of available bidders to hosts and absent very strong safety prequalification customization requirements, should generally be part of a model safety prequalification program.

While bid lists are one way to address the safety-procurement tradeoff, exempting inherently safe work from contractor safety prequalification is a second method for balancing the benefits and costs of safety prequalification. Carving out work to be exempted from prequalification in many cases can be simply a matter of common sense. Cafeteria work or the refilling of vending machines in a chemical plant may simply be jobs that are not involved in the truly dangerous work associated with the basic operations of the facility. If the work is truly safe and truly disconnected from more dangerous work, then it might be safely carved out of the contractor prequalification system. More generally, all work could be assessed for the degree of risk it entails. This would have a double benefit. First, it would allow the safety prequalification rigor to be calibrated to the benefits of minimizing inherent safety risks. Second, it can provide the information contractors need to properly bid the work and to align their expectations regarding the work to the expectations of the host. In our survey of large employers, we found that the larger the host, the more likely they were to risk assess work to be given to contractors. If the host used a safety prequalification service, they were also more likely to safety assess the work. The more work they contracted out, the more they safety assessed the work to be let. And the more they were concerned with the restriction of bids, the more they risk-assess the work—probably to make sure the benefits of safety prequalification were sufficient to meet the perceived costs associated with restricted bidding.

Interviewed hosts were close to unanimous in stating that contractor safety culture was an important indicator of the future safety performance of the contractor. However, teasing out contractor safety culture in a safety prequalification system can be difficult

and expensive. So any model of safety prequalification must address the tradeoff between inexpensive indicators such as the documented presence of a safety plan and expensive indicators such as on-site inspections with interviews of the contractor's workers. Sometimes inexpensive is good enough. As indicated above, simple projections of past performance might capture 80% or more of current performance. But when safety risks are high, missing 20% of the possibilities can be disastrous.

Even on-site visits might focus on the less expensive information to be gathered. Surveyed large hosts indicated that for them, the most important indicators from onsite visits would be simply that the workers were wearing the appropriate personal protective equipment and the contractor had the appropriate work permits available for inspection. These ranked higher than the possibility that the field auditor concluded that management is or is not truly committed to safety. Obviously, if management were truly committed to safe work procedures, this would speak volumes regarding whether the contractor had a good safety culture.

We think hosts implicitly recognized that there is a tradeoff between subjective-encompassing criteria and objective-but-more-narrow criteria. Any model of contractor safety prequalification needs to address the subjective-objective information tradeoff. These information tradeoffs involve not only assessment of such present-capacity factors such as culture but also past performance measures such as near-misses. Subjective criteria can be more nuanced and encompassing but one man's near miss can be another man's non-event. Objective criteria tries to be such that all can agree whether the criterion was met or not. But the narrowness of objectivity can possibly mean that the

criterion is not measuring what the system hopes it is measuring. Everyone wearing hard hats may mean little regarding the true safety culture of a contractor.

Safety prequalification is a process of selecting a contractor, and in most cases, models of safety prequalification are pass-fail systems. The contractor is not qualified until the contractor meets certain criteria. But this need not be. Point systems can be used instead. In a so-called best value system, safety is given a certain weight in the overall selection process. Other factors, including the contractor's bid price, are given weights as well. One contractor might get scored highly on service quality, another on safety, and a third on price. Based on the points given for each factor and the weights given between factors, one contractor will score higher than the others and win the bid. The winning contractor might be the safest or the cheapest or somewhere in between the two extremes. Explicitly, point systems are not yet common in safety prequalification. Most hosts use a pass-fail system with exceptions—exemptions for safe work; exceptions for emergency work; exceptions for when only one contractor out there can do the work. Some hosts use implicit point systems where the safety officer informs the procurement officer of the safety standings of applicant contractors and the procurement officer makes a judgment. But exemptions and judgments are point systems. They just are not explicit point systems quantifying the tradeoffs of safety against other factors in the procurement process. Models of safety prequalification should consider making tradeoffs between safety and other factors explicit so that decision makers truly know what they are deciding.

One problem, however, with point systems is that they send an indefinite signal to contractors. In the pass-fail system, contractors know why they failed and know what

they can do to pass the next time. This puts strong selective pressure on the contractor community which in the long run will enhance that community's collective safety capacity and lower the long run costs to hosts of obtaining safe contractors. The point system may make host decisions clearer to hosts, but it jams the safety signal meant to be sent to contractors. If I did not win the job today because another contractor beat me out in safety points, I can beat that contractor tomorrow by improving my safety, or I could just simply lower my price. Multidimensional competition implied by point systems will not as quickly or as clearly lead to a safer contractor community.

We have suggested above that in perhaps most cases, ideal models of contractor safety prequalification should involve multiple-host cooperation in some form in order to spread the cost of prequalification across more work. Once the solitary-joint tradeoff has been faced, models of safety prequalification must face the tradeoff between contractor prequalification and contractor-worker prequalification. Local safety councils do contractor-worker prequalification. Some worker safety criteria are fairly generally applicable across many industries such as drug testing or perhaps criminal background checks. Even some safety training has wide applicability across many industries. But as the safety training becomes more specific and more applicable to one industry, often it becomes less applicable to other types of work.

Local safety councils tend to be local because specific regions may have host employers with similar needs, contractors with similar capabilities and workers who slot into this segment of the economy. In this context there are economies of scale to be harvested not only in prequalification testing but also in the training of workers. But by harvesting these economies of location, local area safety councils are less well positioned

to geographically expand compared to the prequalification service providers who are less rooted in location and industry. Safety councils try to partially remedy their rootedness by creating reciprocity agreements with other local safety councils. While prequalification service providers tend to expand their business by growing, local safety councils tend to expand their scope through reciprocity. However, these are only tendencies. There are currently some tentative experiments among service providers in creating alliances with training or drug testing companies while local area councils are sometimes expanding geographically into new areas where there might be sufficient concentration of industries to exploit their services. In the UK there are even experiments in cooperation between safety prequalification providers and financial prequalification service providers.

A knowledge of the evolution of safety prequalification services in the market is crucial for the design and refinement of safety prequalification models because as the structure of this service industry evolves, the potential economies of scale will change altering the basic tradeoff between safety and procurement in the favor of safety.

This report presents a model of safety prequalification in terms of tradeoffs rather than with one recipe because contractor safety prequalification is a rapidly moving and evolving target. Optimal strategies today will be quickly outmoded by market innovations and perhaps changes in the way government gathers data and regulates safety. These factors will alter basic tradeoffs and change best practices. The perfect safety prequalification model is no more a lasting concept than the perfect personal computer. What analysts and practitioners need to know are the basic tradeoffs they face when designing their own safety prequalification system, bringing a safety

prequalification service to the market, and/or participating in one such system as a contractor or host.

## Chapter 5: Testing the Effectiveness of Safety Prequalification of Contractors

With reliable and broad information feedback loops overlaying specific forms of contractor safety prequalification, it becomes possible to test and refine those systems. Testing involves the creation of numerator and denominator data where in the numerator are various measures of unfavorable safety outcomes and in the denominator are measures of contractor exposure to risk. Standard numerator data such as injury rate, restricted duty injury rates, lost workday injury rates, average days lost per lost-day-case and fatality rates need to be supplemented with new measures that capture near misses, large events, property damage and various alternative measures of injury seriousness such as all injuries involving x or more workdays lost, and cost of medical treatment. Near misses need to be included despite the subjective problems in defining and reporting near misses simply because both fatalities and catastrophes are rare events best predicted by more common events. Injuries are one such common event but near misses associated with potentially large events are needed to supplement the other measures we have.

Hosts focus on the measures we have because Bureau of Labor Statistics injury measures and EMR rates are what is available. With broad and reliable feedback loops in place overlaying safety prequalification systems, the opportunity emerges to add to available government measures. We cannot know now which of the various plausible supplemental measures of safety outcomes will prove to be most efficacious in predicting

serious injuries, large events, fatalities and catastrophes, but the statistical tools needed to find out are well established. We only await the data to begin the testing.

But the testing will also require denominator data measuring contractor exposure to risk. Again there are conventional measures—mainly the contractor's worker hours sometimes handicapped by the types of occupations the contractor employs. This is a risk-adjusted exposure measure, but with the safety prequalification system in place, other risk adjustments are possible. Our survey indicates that among responding hosts, around 16% never risk assess the work they let to contractors. That does not mean all other work is risk assessed. Sometimes it is. Sometimes it is not. But as we argue in this report, risk assessment is a useful tool in deciding what work to safety prequalify and in informing contractors of the nature of the risks they face and the expectations of the host regarding those risks. So in a model safety prequalification system, job-risk-assessment would be more common. That information should go into the information feedback loops before any accident occurs. This then would provide additional information to handicap the contractor's safety outcomes based on the risk exposure the contractor faced.

Contractor safety prequalification can be tested in two ways—overall effectiveness is a question of whether prequalification, in general, is superior to not safety prequalifying contractors. Detailed effectiveness is a matter of which prequalification criteria provide the best cost-benefit ratio in selecting contractors. Both questions are important and both create control-group or benchmarking problems.

The overall question of safety prequalification presents the problem of finding data on safety outcomes and exposure when contractors are not safety prequalified. The feedback loops discussed above overlay safety prequalification, and by their nature,

provide limited data on what happens when safety prequalification does not take place. Here the government is needed to provide information from host employers who do not prequalify regarding the safety outcomes and exposures on their sites. In the meantime, prequalifying hosts can achieve a second best by comparing outcomes on the work they do safety prequalify with the work that they do not. Unfortunately, this will often entail apples and oranges comparisons because most of the work that they do not safety prequalify will be work that is exempted from prequalification because it is inherently safer work.

The detailed question of which safety criteria work best can be answered with the information in the feedback loops. Problems can emerge if the host is using a go-it-alone prequalification strategy and sample sizes are small. Other problems can emerge if all hosts converge towards a limited number of approaches at screening contractors. Wide experimentation will generate more information about what works.

But whatever works, it will only work for a time. There is a half-life to safety screening criteria associated with the natural life cycle of safety practices and associated with contractors who game the system. Best safety practices have a life cycle. The hard hat was once a safety innovation. In the 1920s, hosts might have found requiring hard hats so restricting a criterion as to eliminate too many bidders and substantially boost bid prices. As a best practice becomes more common, it hits a sweet spot where it does not restrict bidding significantly but effectively screens out backward and unsafe contractors. But eventually, best practices become common practices which is a good thing. The contractor community is safer. But it is a problem in that the criterion no longer allows hosts to separate the safe from the unsafe contractor.

Furthermore, while some contractors, in order to compete in a safety-prequalified market, will enhance their safety capabilities, other contractors will seek to game the system by simply trying to seem like a safe contractor. Early on, requiring a contractor to have a safety plan may be an effective criterion in separating the safe from the unsafe contractor. But as contractors get wise to the criterion, some will simply have a paper policy that has no relation to workplace reality. This sets up an arms race between the screeners and the pseudo-safe contractors. The contractor gets a policy off the web. The screener calls the contractor and interviews him on his policy. The contractor hires a consultant to learn what to say when the call comes. The screener sends field auditors to talk to supervisors and workers. So what was once a cost effective measure of contractor safety has a half-life as some contractors try to game the system and screeners have to ramp up the cost of screening.

We conclude Chapter 5 with a plea for "open source" contractor safety prequalification. There are not only economies of scale to be harvested through host cooperation in contractor prequalification, there are economies of information to be harvested by various systems of safety prequalification sharing information. The logistics of integrating wider and wider feedback loops is no doubt daunting. Perhaps a government agency or host-sponsored non-profit needs to be established to encourage information sharing and to provide a warehouse for information. In any case, safety prequalification will get better and contractor safety capabilities will improve to the extent that information loops between the screening stage and the outcomes stage are created. Safety engineering and informal host experience are not enough to test the effectiveness of contractor safety prequalification. The proof is in the pudding.

NOTE: two additional chapters summarizing the results of our host surveys are provided at the end of the report but not summarized here.  Many of these survey results are used in various sections of the preceding chapters, but several stand-alone results in Chapters 6 and 7 may be of interest to the reader.  Chapter 7 involving the RMCOEH survey also compares the RMCOEH average-sized-host results to the ORC large-host survey summarized in Chapter 6.

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# Chapter 1 Selected Literature Review

## *Introduction*

Safety prequalification of contractors is an intervention designed to reduce injuries on the job.  Its potential effectiveness in promoting safety is contingent upon the factors that compromise workplace safety and how pre-qualification is likely to modify those factors.   In short, the effectiveness of safety prequalification depends on how it intersects with the model, or determinants, of occupational safety.

There is growing appreciation that a full model of workplace health and safety outcomes entails "organizational epidemiology,"  that is, it addresses not just the risky behavior of the specific employees and  the particular technical conditions most proximate to occupational accidents, but takes cognizance of intermediate factors, such as the quality of training and maintenance, and more broadly,  the "root causes" of safety outcomes (Rosenthal1997a, Rosenthal   Kleindorfer and Elliott 2006).   Such root causes are increasingly seen to be embedded in the organization and management of the firm, in the structure of the firm's safety management program and how it is integrated into, and prioritized within, overall firm management.  Firm management and its commitment to safety, in turn, is seen to be affected by an even broader context, including the industrial market structure, the social and economic climate, as well as by the prevailing regulatory and legal regimes, under which the firm operates.  (Rosenthal 1997a, Manuele, 1997). This model of "organizational empidemiology," Rosenthal argues, is therefore akin to the model in public health of the socioeconomic gradient in health, where individual behavior is understood within the larger context of resource distribution and the stressors

that are attendant to it.  Firms in the lower quartile of profitability, for example, may be more inclined to cut back on training for workplace safety, skimp with respect to maintenance, face higher turnover, and thereby experience a higher risk of accidents (Rosenthal, 1997a).

The paradigm shift in occupational safety and health from emphasis on technical controls to greater focus on process safety systems emerged in the 1980s and 1990s as several prominent, low probability, high consequence (LP-HC) accidents, particularly in the petrochemical industry,  continued to transpire despite the fact that technical controls were often in place (Rosenthal, Kleindorfer and Elliott 2006).   This shift in emphasis was reflected in process safety management standards promulgated by both the Occupational Safety and Health Administration (OSHA) and the Environmental Protection Agency (EPA) subsequent to the 1990 amendments to the Clean Air Act (Rosenthal,  Kleindorfer and Elliott  2006).  The "safety culture" of the firm has therefore drawn greater focus from scholars in the field of industrial safety (Manuele, 1997), with greater emphasis on development of rigorous metrics that identify measurable characteristics of that culture which could translate into meaningful reduction of workplace risk (Rosenthal,  Kleindorfer and Elliott 2006).

While the literature on organizational epidemiology of workplace health and safety continues to expand, there has been little published analysis, specifically, of how safety prequalification of contractors may be situated within such a model.  This literature review therefore is two-pronged: first, it focuses on literature that provides historical insight on the trajectory of prequalification--why it has come to the fore now as an important intervention and how it has taken shape as an enterprise; and second, it

emphasizes aspects of the occupational safety model culled from the literature that are most relevant to, most likely to intersect with, and most conducive to modification by, pre-qualification.


## *The Context for Growing Interest in Pre-Qualification*

**Contract work on the rise.** A growing interest in safety pre-qualification of contractors has historically paralleled the rise in contract, temporary, and other types of "contingent" work arrangements over the past several decades. These changes in the employment relationship, and their implications for regulation of labor markets, have been addressed in several studies (Abraham, 1990; Appelbaum and Batt, 1994; Mangum, Mayall, and Nelson, 1985; Carnevale Jennings, and Eisenmann, 1998). Who bears liability for labor law and safety violations in the multi-employer context is an evolving issue, and has received particular attention in the construction industry, where contracting and sub-contracting is pervasive. Liability of general contractors for safety violations was originally contingent on an employer's own employee being exposed, with the definition of "employee" being the focus of law. But liability of general contractors expanded over time to employees of sub-contractors. The Occupational Safety and Health Review Commission (OSHRC) maintained that general contractors had a responsibility to oversee OSHA compliance among sub-contractors. In a landmark case, Marshall v. Knutson Construction Company, the U.S. Court of Appeals for the Eighth Circuit upheld OSHRC's standard holding general contractors responsible for violations "it could reasonably have been expected to prevent or abate by reason of its supervisory

capacity." (Carnevale, Jennings and Eisenmann 1998). This reasoning has also applied to the host employer in relation to general contractors, although the legal interpretation is still evolving. As the host employer is more exposed to liability with respect to contract employees, clearly the interest in mechanisms to improve safety, such as pre-qualification, has garnered greater interest.

**The liability link.** The link between location of liability in the host-contractor chain and interest in contractor safety is certainly of material interest on the part of the host employer with respect to job safety. The John Gray Institute report (Wells, Kochan, and Smith, 1991), discussed in more detail below, pointed to co-employment liability concerns as a major factor in compromise of health and safety in the petrochemical industry as a result of increasing reliance on contract work. This link between liability and interest in contractor safety is sometimes not just a byproduct of case law, but in certain instances stems more directly from contract terms. It has been the tradition for certain host employers within the petrochemical industry, for example, to pay for worker compensation costs as part of the contract (Rebitzer, 1998). As discussed further below, the Department of Energy, perhaps somewhat uniquely in the public sector, has also traditionally taken the responsibility for paying for worker compensation and injury costs of contractors (Finn, 1995). There is a well recognized tension in the literature between liability and incentives. If health and safety responsibilities reside strictly with direct employees, then incentives tilt on the part of host employers for keeping training, oversight and management of health and safety of contractors at arms length (Finn, 1995; Rebitzer, 1998). On the other hand, if liability law and contracts accord direct

responsibility to the host employer, then incentives shift toward more intimately managing health and safety practices contract employees. As maintained in our several interviews with safety management professionals in industry, and with those directly involved in the enterprise of safety prequalification, prequalification of contractors, depending on how it is undertaken, can be regarded both as a form of hands off, minimum certification of contractors or as a critical stage in the more intimate oversight and management of workplace health and safety.

Of course, there are incentives other than strict liability concerns with respect to contractor health and safety and potential interest in contractor health and safety pre-qualification, as was made clear in those interviews as well. As the contracted workforce grows in proportion to the total workforce at the firm, and contracted workers become more integrated with host employees, the potential spillover effects of contractor health and safety practices onto direct-hire employees looms larger. Evidence on studies regarding the size of the contingent workforce and safety outcomes among firms in the petrochemical industry bears on this issue, and discussed further below (Rebitzer, 1998). Other institutional features of industrial organization and labor relations appear to be important. The extent of unionization of plants, for example, often has important effect on wages and benefits owed to nonunion contract employees, and may affect the liability of the host employer for contract employees. The culture of safety subscribed to and promoted by the host employer is considered to be critical to the overall safety performance of the firm, as discussed below (Manuele, 1997), and likely provides incentives to pre-qualify contractors beyond those inherent in strict and immediate liability concerns.

Liability issues also play a potentially pernicious role with respect to the gathering and sharing of information surrounding industrial accidents. Accident prevention analysis is fundamental to conducting "root cause" investigation of accidents, but an understanding of the etiology of accidents can potentially create exposure of the firm to liability (Rosenthal, 1997b). The tension between liability and analysis has created a significant impediment to organizational learning (Rosenthal, 1997b). Root cause analysis of major accidents may even be cost-effective in the long run, not just from a societal perspective, but even from the vantage point of the firm's long-term financial viability; but, because managerial compensation is generally tied to short term financial returns, such analysis may not be undertaken due to concern over liability (Rosenthal, 1997b). Remediation of this market failure, or inefficiency, may require careful review and modification of liability law. Other issues surrounding economic efficiency are addressed in the next section.

**Economic efficiencies versus economic power.** It is not the primary objective of this report to address the underlying factors that have been driving greater reliance on contracted labor in the workforce. Some of the industrial relations literature cited earlier have provided insights on this issue (for example, Appelbaum and Batt, 1994, Barker and Christensen, 1998), as did the John Gray Institute Report (Wells, Kochan, and Smith 1991). But part of the industrial organization literature on the vast vertical and horizontal integration, and changing contractual relationships, in the health care industry that took off in the 1990s may be instructive with respect to understanding the underlying economic motives behind the growing reliance on contract labor in

general, and can inform the conditions under which safety pre-qualification will be most effective.

"Formal integration" is the term that characterizes firms extending their employment relationships in the supply chain either horizontally (as when one petrochemical firm merges with another) or vertically, (as when oil drilling and refining are merged). "Virtual integration," on the other hand, has been coined to characterize the extension of contractual relationships, such as when doctors coalesce horizontally in independent practice associations (IPAs) rather than into group-model HMOs (Robinson and Casalino, 1996). Some theorists have probed the question as to why firms engage in "virtual," or contractual, integration, as opposed to formal integration. Some of the motivation is in the true economic efficiencies to be exploited. Economies of scale, for example, are efficiencies gained when consolidation reduces unit average cost, either through spreading administrative or other types of fixed cost, or by exploiting some technical economy not available at smaller scale. The traditional arguments associated with economies of scale do not necessarily militate in favor of formal integration--those economies may be achievable through contractual integration, as administrative economies can be exploited under loose, contractual IPA arrangements of physicians as readily as through tight, formal group practice (Robinson and Casalino, 1996). Formal vertical integration of firms is often justified on efficiency terms due to the reduction of "transactions" costs, that is, the terms of contracts, including their enforcement are always incomplete, and establishing those terms for exchange along the supply chain might be more costly than simply acquiring the capacity internally. On the other hand,

"virtual" acquisition, through contracting for work rather than adopting formal ownership, could also reduce certain transactions costs associated with personnel, such as negotiating wage and benefit agreements and administrative costs in enforcing employment contracts. Contracted work can potentially allow for greater flexibility in meeting specific needs in the operation at specific times, such as turnaround, and may be associated with work incentives that result in higher productivity, as termination of contract may be easier with respect to contracted than direct-hire work (Wells, Kochan and Smith, 1991).

Robinson and Casalino note, however, that economies of scale and reduction in transaction costs may not be the only factors involved in the decision to formally versus virtually integrate. The issue of a shared culture and innovation, they note, may also be critical factors. In formal integration, a shared organizational and managerial structure may inculcate a culture within the firm that engenders joint problem-solving and other innovations that lead to cost reduction. The dedication to such a process, in the absence of a shared culture is less likely to materialize under certain contractual associations (Robinson and Casalino, 1996). They note, however, that the potential efficiencies that result will depend on the actual nature of firm organization and managerial approach. Formal integration may result in encrusted leadership that is resistant to even cost-reducing change, whereas a looser, contractual bond may in certain instances promote innovative problem-solving that would be less likely to transpire if all workers were under the same roof. This aspect of economies associated with a shared organizational culture has stark similarity to the emphasis in the workplace safety literature on the importance in safety management for establishing a vital safety culture at the firm

(Manuele, 1997; Rosenthal, Kleindorfer and Elliott 2006). Although this literature does not explicitly address the difficulties in extending such culture in a multi-employer framework, that is, a workplace with extensive contracted work, it is a logical extension.

But as Robinson and Casalino make clear, the incentives to formally versus virtually integrate may not have anything to do with true economic efficiencies at all, but instead with the exercise of economic power. Firms may use their power to shift costs to other entities, as when a firm seeks to release itself from the wage and benefit terms of a union agreement, or when it seeks to shift safety and other forms of liability onto other parties. This has nothing to do with true economic efficiencies from a societal standpoint because one unit's loss is another's gain. If contractors expand and merge to obtain greater bargaining strength when negotiating with consolidated and concentrated host employers, then such bilateral "monopolies" may result in contractual terms that are more efficient than if the contractor remained small, but from economic theory, such efficiencies depend on relative bargaining strength and may be "second best" to a more competitive market structure. In terms of safety performance, in other words, the growth of contracted work may reflect the desire to shift liability costs in a non-competitive environment rather than achieve true economic efficiencies. Reconfiguring the relative burdens in liability law and tailoring mechanisms, like mandatory safety pre-qualification, in a way dulls the incentives to cost-shift, could help promote contractual relationships and virtual integration when true efficiencies, in the pure economic sense, are exploitable.

**Information issues.** Information issues abound with respect to concerns over contract worker safety and the use of pre-qualification. The data that is most often used

to screen bidders, including OSHA 200 logs and worker compensation EMRs are subject to flaws in reporting, and smaller firms may be at a distinct disadvantage with respect to maintaining accurate records. The incentives in record-keeping are also become important when such information is used as a gateway for successful bids. Even if such information were reliable and accurate, there is some debate as to whether indicators from past performance are good and comprehensive gauges for future performance (Finn 1995). Certainly, pre-qualification has tended to rely on collection of data that may be least costly to acquire and somewhat straightforward to officially verify, but the value of such information in terms of predicting future safety outcomes is of some concern. More active investigation of firm's organization and management practices regarding safety may make the pre-qualification process more accurate and meaningful, but acquisition of such information also comes at a cost. There is therefore a tension in the cost-benefit calculus with respect to the nature of pre-qualification, and it is clear that more extensive procedures will be undertaken the greater the exposure to risk of an adverse outcome. Hence, it is not surprising to see industry variation in reliance on prequalification, and for the interest in pre-qualification to vary across size of firm, size of contract, length of tenure of workers on site, and other factors that intimately relate to this cost-outcome calculus.

The petrochemical industry in the private sector, and the Department of Energy in the public sector, perhaps became the focus for initial investigation into the use of safety prequalification because the circumstances surrounding use of contract work in these sectors that turned the cost-outcome calculus in favor of gathering more reliable information prior to bid.

**Petrochemical Industry as bellweather: the John Gray Institute**

**Report.** The explosion and fire at the Phillips 66 Houston Chemical Complex in Pasadena Texas on October 23,1989, where 23 people were killed and 232 were injured, represented for OSHA the most extensive loss of life in a non-construction workplace accident in the history of the agency to date (Wells, Kochan, Smith, 1991). Four of the fatalities were the employees of an on-site contractor, Fish Engineering and Construction. That accident prompted the Occupational Safety and Health Administration (OSHA) to commission a study of safety and health issues relating to the use of contract labor in the U.S. petrochemical industry, the so-called John Gray Institute Report (Wells, Kochan, Smith, 1991). The study undertook extensive surveys of plant managers, individual contract and direct-hire workers and contractors with respect to management of safety, as well as nine case studies. The report found that 38% of employees work in plants in the industry that do not have formal procedures for selecting contractors based on their safety records. While substantial percentages of contractors in the industry submitted OSHA 200 logs, worker compensation EMRs, and other information on their own health and safety records (40%, 63%, and 34% respectively), such reporting was related to firm size (number of contract employees on site) and longer on-site tenure. Nearly all those not submitting information were not required to as part of the bid process (Wells, Kochan, Smith 1991).

Case studies in the report confirmed the relationship between rigorous and active contractor screening and safety outcomes. The report concluded that the labor-management tensions created by contract work in the petrochemical industry, were

fundamental to enhanced risk to job safety.   Results of the most comprehensive

multivariate analysis undertaken of some of this survey data pertaining to contract work

and health and safety outcomes (Rebitzer 1991) is presented below and confirm the

overall conclusion.  Although the findings were somewhat controversial, due in part to

questions over the sample bias in the surveys, the report highlighted major issues with

respect to contract work in the petrochemical industry, particularly related to tension in

labor-management relations that compromised safety culture that, in retrospect, served as

a bellweather for the development of interventions, amongst them contractor safety pre-

qualification, to address the particular issues over safety that arise with contract work.

Subsequently, the firms and trade associations in the chemical industries, began to

experiment with new practices to improve health and safety related to the growing

prominence of contract work.   Highlighted in terms of "best practice" was an exemplar

case study where there was intimate involvement in safety management and oversight by

the host employer for contract work, that is, the extension of host culture over safety

concerns, to contract employees.  Every facet of the contract worker integration that

might affect safety, including training, bid pre-qualification, and wages, and

incorporation of substantive employee participation in reporting problematic conditions

were part of an active management strategy on the part of the host employer.  As in the

multivariate results presented below from the surveys undertaken by the John Gray

Institute report, reduction in the tension over liability concerns which enhance active

management and extension of safety culture according to the principles outlined in the

major texts on process safety management (Manuele, 1997, Peterson, 1996) is a

necessary prerequisite for promoting health and safety in the context where reliance on

contract work is extensive.  Safety pre-qualification is consistently indicated as one critical tool within a more comprehensive set of tools (training, safety committees, worker participation, safety culture) required to achieve that outcome.

The John Gray Report also pointed to several barriers to the extension of "best practices", one of which was liability concerns.  Others included labor-management tensions, tension between direct-hire and contract employees, but also the absence of information on what works, and mechanisms for diffusing best practices amongst firms. To the extent that safety prequalification can serve to amass information in a way that can facilitate systematic investigation of what works and then provide a natural mechanism for its diffusion, the pre-qualification process itself could, in addition to directly promoting safety through proper screening, potentially reduce this barrier to "best practices."

**Prequalification in Public Contracting, the case of DOE**--The public sector has a long-standing tradition in the use of contract work, such as in federal defense procurement and construction of federal buildings and roads.  No comprehensive analysis has been undertaken of the nature and use of safety prequalification under government contracts, but some literature provides insight as to the scope of its development and use.

The Department of Energy (DOE) has traditionally expended a significant amount of its health and safety resources in safety management within nuclear facilities, whereas a preponderance of lost-time injuries and fatalities occur where more conventional hazards are encountered, particularly in construction, but also in maintenance (Finn,

1995).   As noted above, the DOE has a particular interest in the economic consequences

of contractor injury, as it largely foots the bill for worker compensation and workplace

injury costs of contractors (Finn, 1995)  Under DOE Order 5480.9, in place since 1980,

very broad principles for contractor health and safety established that "contractors

bidding on or selected for DOE construction contracts" provide a "descriptive outline" of

a program acceptable to the contracting officer that contains "adequate provisions" for

safety, such as emergency aid, trainings, inspections, reporting, and safety certification of

equipment among other activities.

Due to the rather vague language, the order resulted in high variance in the quality

of safety programs across DOE activities and contractors.  A working group was

therefore established to arrive at a set of best practices (Finn 1995).   Included as one of

the working group's set of seven elements to be integrated into a revised Order was

"contractor qualifications."  Others included

- A written plan clearly outlining responsibilities and establishing modes of
  coordination of safety and health programs of subcontractors

- A formal written plan of project hazards

- Employee training appropriate for hazards

- Minimum acceptable level of on-site verification by both construction
  manager and the DOE project manager.

The use of pre-qualification, relying on OSHA 200 log and worker compensation

EMR rates was seen to be fundamental to the system.  But, the use of prequalification in

federal contracts, however, was also seen to encounter particular problems, for example,

reducing the number of competitive bids, for which there needs to be a written

justification demonstrating compelling circumstances " . . . [T]he fundamental tenet of federal procurement policy, fair and open competition, would be compromised by the indiscriminate use of indicators such as the experience modifier or incidence rate" (Finn 1995, p. 19).   Finn also raised the concerns addressed in the literature regarding the value of these particular indicators of past performance, imperfect in and of themselves, in gauging commitment to safety and future performance (Finn, 1995).  The tension inherent in limiting competition with pre-qualification versus relying on demonstrated satisfactory performance is clearly one that the public sector has not been immune to.

      **The safety prequalification industry**. No literature has dedicated itself to exploring the burgeoning safety prequalification industry in the United States, but issues regarding its structure, its clientele, its potential exploitation of economies of scale with respect to information-gathering and information-sharing amongst host employers are addressed in other sections of this report, as are the various forms that the pre-qualification service industry has taken in certain sectors of the economy and regions of the country.[2]   This section is dedicated to the description of a large safety pre-qualification service organization in Europe, the Contractor Health and Safety Assessment Scheme, or CHAS.

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[2] In the United States the two primary sectors of the safety prequalification industry are for profit safety prequalification service companies and non-profit local area safety councils.  There is no secondary academic literature on this emerging industry but one can obtain primary source literature from company annual reports when available.  An example is the Contractors Aafety council Texas City *Annual Report* 2006.  These reports will summarize company or council activities, provide mission statements, etc.  More research is needed on this sector of the economy and the CHAS case study is, as far as we know, the first case study of these sorts of companies.  It is beyond the scope of this report to do company by company case studies but a general description of these two segments of private sector contractor safety prequalification are provided in subsequent chapters of this report.

CHAS is a nonprofit contractor safety prequalification service owned by local public authorities including the London Borough of Merton.[3]  CHAS serves about 300 host employers, about half of which are public agencies, in England, Scotland and Wales. In December, 2007, CHAS had about 18,000 safety prequalified contractors, about three-quarters of which are construction contractors.  The predominance of construction contractors reflects CHAS' origins in the public sector where public host-employers/owners tend to disproportionately procure construction services.  Again, reflecting the character of construction, 38% of CHAS' contractors have 10 or fewer employees; another 36% have between 11 and 49 employees; 18% of CHAS contractors have between 50 and 250 employees with the remaining 8% have over 250 employees.[4]

CHAS operates within a regulatory environment structured by the Health and Safety at Work Act (1974), the Management of Health and Safety at Work Regulations (1999) and the Construction (Design and Management) Regulations (2007).[5]  This regulatory environment creates legal requirements including safety standards that are left to host employers, third-party, non-state insurers, construction customers and others including safety prequalification service agencies/companies to enforce.[6]  Contractor safety prequalification is strongly encouraged by this regulatory envelop.  This has resulted in a proliferation of primarily private safety prequalification schemes across the

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[3] See: http://www.chas.gov.uk/  and  http://www.merton.gov.uk/working/chas.htm (accessed December 19, 2007).

[4] Howard Fidderman, *RoSPA NOSHC Inquiry into OSH assistance to SMES*, 2nd report: Core criteria in pre-qualification schemes, 29 November 2007.  While the second report is not posted as of December 2007, in the future it may be accessed at the Royal Society for the Prevention of Accidents website: http://www.rospa.com/ .  Also at the time of this writing, the author may be contacted at hfidderman@mac.com .

[5] See: Wikipedia: Health and Safety Work Act 1974, http://en.wikipedia.org/wiki/Health_and_Safety_at_Work_etc._Act_1974;  and also, http://www.hse.gov.uk/construction/cdm.htm ; http://www.opsi.gov.uk/si/si1994/uksi_19943140_en_2.htm (accessed December 19, 2007).

[6] Fidderman, pp. 3-4.

economic landscape from restaurants to refineries. Highly dangerous operations such as chemical plants, railway work, offshore oil extraction and petroleum refineries have rigorous contractor safety prequalification procedures that may include site inspections of the contractor's work. However, in most cases, including general construction which is the heart of CHAS's activity, prequalification service providers focus on general safety competency assessed by a questionnaire, the examination of documents and occasionally a telephone interview with the contractor. More detailed examination of a contractor's safety prequalifications is left to the host employer ususlly at the invitation to tender stage..

In the UK environment, there are typically three stages for assessing competence of contractors. CHAS does stage 1 , only, which involves the assessment of a contractor safety prequalification questionnaire and supporting documents and evidence. This is a general prequalification stage in the sense that it is not done in the context of obtaining specific work from a specific host employer on a particular project; but rather stage 1 is done more generally in order to qualify the contractor for work any time within the subsequent two years with any of the host employers participating in the scheme. (After two years, the prequalification must be renewed.) A second stage is implemented by the host employer in the ramp up to the bid opening for a particular project or job. At this second stage, the host is responsible for assessing the competency of competing contractors relative to the specific hazards of the work to be done. (They are encouraged (strongly) not too revisit any of the elements covered at stage 1).

CHAS is designed with an escape clause so that contractors may skip the first stage of prequalification and meet both first and second stage host-standards at the bid

preparation stage.  This exception is designed particularly to facilitate European

procurement laws and protect non-UK (EU) contractors who are interested in a specific

UK project but may not generally bid on UK work; These non-UK contractors are

generally not interested in qualifying for work from the participating group of UK host

employers.  Nonetheless, the stage one prequalified list of contractors typically describes

the universe of contractors participating hosts will draw from in procuring contracted

work.

A third stage involves monitoring the selected or appointed contractor on the

assigned work.  This post-award is a "prequalification" stage in the sense that failure to

perform to the host's safety expectations can result in the contractor's poor performance

becoming red-flagged on the CHAS database, thus potentially preventing the contractor

from obtaining future work among participating hosts.  This is a low probability, high

cost outcome for contractors that CHAS believes serves as strong incentive for

contractors to perform their work safely.  This red-flagging is an informal process up to

the host's discretion.  CHAS hopes to create more formal feedback loops between its

database and contractor outcomes on hosts' projects in the future.  (See below.)

What CHAS does is a "desktop audit" (or assessment) based on general criteria

with the host subsequently being responsible for job specific prequalification and

monitoring.  This dividing safety prequalification into two stages permits the first stage to

be general, widely applicable and capable of capturing broad economies of scale in the

administration of the first stage of contractor safety prequalification.  However, to some

extent, it may also simply shift costs to the second stage loading onto the host significant

information-gathering costs.  For this to be an efficient tradeoff, the general requirements in the first stage need to be relevant.

The question of what that the general criteria should be is left to each safety prequalification service.[7]  Because there are multiple safety prequalification services and because these services may establish different safety criteria, contractors may have to prove their credentials multiple times and in multiple ways.  Duplication of prequalification and lack of uniformity in prequalification standards increases safety prequalification costs and vitiate the scale economies associated with stage 1 prequalification. This has led to an effort by the SEC [Specialist Engineers Contractors] Group encouraged by the UK Health and Safety Executive to establish core criteria for assessing construction contractor safety.[8]  There are twelve SEC core criteria shown in Table 1.

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[7] Or host employer if it is doing its own stage 1 contractor prequalification.
[8] SEC [Specialist Engineers Contractors] Group, *Core Criteria for Assessing Contractor Safety*, SEC Group, 34 Palace Court, London W2 4JG, Tel: 020 7313 4819 Fax: 020 7727 9268, Email: contact@secgroup.org.uk www.secgroup.org.uk, www.**sec**group.org.uk/pdfs/health/**core**crit07.pdf , http://www.merton.gov.uk/working/chas.htm (accessed December 19, 2007).

| | CORE CRITERIA | STANDARD TO BE ACHIEVED (BY THE CONTRACTOR) |
|---|---|---|
| 1 | H&S policy and organisation (five employees or over) | Have and implement an appropriate policy, regularly reviewed, and signed by the MD or equivalent. The policy should be relevant to the nature and scale of the work and set out responsibilities for health and safety (H&S) management at all levels in the company. |
| 2 | Arrangements for ensuring H&S measures | These should set out the arrangements for H&S management and should be relevant to the nature and scale of the work. They should set out how the company will discharge duties under CDM 2007 and other relevant H&S legislation, with a clear indication of how these arrangements are communicated to the workforce. |
| 3 | Competent advice - company and construction/sector related | The company and its employees must have ready access to competent H&S advice, preferably from within the company. The advisors must be able to provide general H&S advice, and advice relating to H&S issues on site. |
| 4 | Training and Information | Have in place, and implement, training arrangements to ensure employees have sufficient skills and understanding to discharge their various duties. Have a programme of refresher training (e.g. a CPD programme or life long learning) that will keep employees updated on legislation and good H&S practice. This applies throughout the company from top management to trainees. |
| 5 | Individual qualifications and experience | Employees should have the appropriate qualifications and experience for the assigned tasks, unless they are under controlled and competent supervision. |
| 6 | Monitoring, audit and review | Have a system for monitoring procedures, for auditing them at periodic intervals, and for reviewing them on an on-going basis. |
| 7 | Workforce involvement | Have, and implement, an established means of consulting with the workforce on H&S. |
| 8 | Accident reporting and enforcement action; follow up investigation | Records of all RIDDOR-reportable events for at least the last three years. Have a system for reviewing other incidents, and recording the action taken as a result. Record any enforcement action taken against the company in the last five years, and action taken to remedy any enforcement-related issues. |
| 9 | Sub-contracting/ consulting procedures (if applicable) | Have arrangements for appointing competent sub-contractors/consultants. Be able to demonstrate how to ensure that sub-contractors will also have arrangements for appointing competent sub-contractors or consultants. Have arrangements for monitoring sub-contractor performance. |
| 10 | Risk assessment (leading to a safe method of work if necessary) | Have procedures in place for carrying out risk assessments and for developing and implementing safe systems of work/ method statements. Note: this *should include* occupational health issues. |
| 11 | Co-operating with others and co-ordinating work with other contractors | Illustrate how co-operation and co-ordination of the work is achieved in practice, and how others are involved in drawing up method statements/safe systems of work. |
| 12 | Welfare provision | Able to show how the appropriate welfare facilities will be in place *before* people start work on site. |

**Table 1: UK Core Safety Criteria for Stage 1 Prequalification of Construction Contractors**[9]

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[9] SEC Group, *Core Criteria for Assessing Contractor Safety*, ibid.

Fidderman notes in his analysis of the SEC core criteria:

- there is nothing specifically in the SEC criteria about sickness absence and return-to-work;

- SEC does not ask about insurance arrangements;

- the SEC standards do not specifically cover some of the criteria frequently found in other schemes … notably first aid, fire and other emergency arrangements...[10]

As noted, under the UK approach to contractor safety prequalification, the separating out of stage 1 from stage 2 helps separate general safety criteria from the specific requirements of a particular host or job.  This provides the possibility of establishing general safety criteria and hence stimulating a search for core standards.  Nonetheless, Fidderman's noticing of what was absent in these 12 criteria underscores the difficulties in obtaining a consensus view of what are the essential safety standards common to all construction.  On the other hand, the generality of these standards suggest the possibility that there may even be the possibility of establishing core safety criteria beyond the confines of one industry.  As Fidderman notes:

> nearly all the criteria could apply immediately to a non-construction environment, although one or two of the criteria or standards might be deemed too construction-orientated for a wider application...[11]

The tradeoff faced in the UK approach is one of economies of scale in implementing safety prequalification associated with general standards, and specific project safety effectiveness associated with more particular standards.  To some extent, stage one standards-generality may save administrative costs only to increase

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[10] Fidderman, p. 8.
[11] Fidderman, p. 8.

administrative costs at stage two if host employers/owners have to increase their scrutiny in order to obtain the customized standards required by their work. In this balancing act, CHAS meets and goes beyond the core criteria proposed by the SEC Group. Fidderman notes that CHAS is among the more detailed prequalification schemes; it looks sat specific hazards in detail; and it specifically addresses emergency arrangements.[12] This greater detail at stage 1 may raise CHAS' costs marginally, but also may lower the host employer's costs subsequently.

CHAS seeks to establish reciprocity agreements with other contractor safety prequalification schemes so that contractors need only prequalify once. Two problems impede reciprocity. First, because reciprocity saves contractors money by reducing the number of times they must prequalify, all other things being equal, this reduces the revenue stream to prequalifying service providers sometime reducing their incentive to reciprocate with other service providers. CHAS sometimes responds to this disincentive by recognizing the prequalification results of other services even when these services do not yet recognize CHAS prequalification outcomes. Second, while there may emerge an agreement regarding minimal core safety standards, when two safety prequalifying companies implement these standards differently or go further than the core standards differently, divergent approaches make recognizing the other's results as yours is problematic. Economies of scale drive reciprocity and large firms have a greater incentive to seek reciprocity while specific prequalification approaches and divergent firm interests impede reciprocity. This dynamic is important because administrative economies of scale are central to reducing the cost of safety prequalification and reciprocity is one form of capturing those economies of scale.

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[12] Fidderman, p. 14.

Beyond reciprocity, CHAS exploits its unusually large size to propel further growth. CHAS has recently ceased to charge host employers/owners (known as clients) any fee in order to participate in the CHAS safety prequalification scheme. This puts pressure on clients to join the system. When CHAS-registered contractors are asked by a host to prequalify through some other method, the contractors often respond: "We are already CHAS prequalified, and you can use that service for free. Why don't you join CHAS (saving us the cost of paying for two prequalifications)?" [13] Thus, the pressures of economies of scale tend to grow the size of the largest safety prequalification schemes while placing the direct cost of safety prequalification onto the contractor and off of the host.[14]

Subcontracting is particularly common in construction and according to CHAS, many of their participating general (or principle) contractors are requiring that their subcontractors be CHAS prequalified. Given that the number of contractors within the construction market grows considerably as the layers of subcontracting deepen, the feasibility of general or principle contractors requiring their subcontractors to participate in safety prequalification is dependent uponthe safety prequalification service having many participating subcontractors within their database. Thus, this is another factor where bigness begets bigness. CHAS is better positioned than smaller prequalification

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[13] Currently, CHAS charges contractors with 5 or more employees around $250 to go through the prequalification process with biennial required renewals for an additional $250. Firms with less than 5 employees go through a scaled-down prequalification procedure for $180. Each contractor evaluation takes about two hours of an assessor's time. In UK law those employing fewer than five people do not have to have their H&S management system in writing and only 7 areas of the core criteria pply, hence the reduced cost

[14] It remains an open question regarding who pays the final cost of safety prequalification—the contractor, the host or the ultimate customer. But if immediate costs fall directly on the contractor, the contractor will be perhaps most sensitive to the costs of safety prequalification.

services to address the problem of prequalifying subcontractors and this is a self-reinforcing advantage.

CHAS does not engage in worker safety prequalification or other forms of contractor prequalification,such as financial qualifications or construction capabilities. However, CHAS has developed a cooperative agreement with Constructionline, a similar quasi-public contractor-financial-prequalification service.  Constructionline maintains a financial database on 10,000 contractors and consultants and currently there are around 90 hosts (i.e. clients) that use the shared services of CHAS and Constructionline to do safety and financial contractor prequalification.[15]

So there are three dimensions in which a safety prequalification service can expand.  The first dimension is expanding its coverage within an industry.  The second is expanding its coverage across industries, and the third is expanding its covering into new areas of contractor and/or worker prequalification. All of these forms of expansion have the potential to capture administrative savings associated with economies of scale, but all confront the issue of generality vs. specificity in contractor prequalification standards. CHAS has sought expansion in all of these areas through reciprocity agreements, alliances, and growth via exploiting the advantages of its own unusually large size.

CHAS does not currently measure the effectiveness of its safety prequalification criteria based on the subsequent safety outcomes of CHAS-prequalified and subsequently hired contractors.  The primary reason for this is the cost of obtaining relevant information given current legal privacy rules and reporting arrangements between CHAS and its 300 hosts.

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[15] http://www.hefma.co.uk/events/constructline.htm (accessed December 19, 2007).

One problem in trying to predict current contractor safety performance based on past and current injuries is CHAS must rely upon honest contractor responses to questions regarding their injury rates. These cannot be confirmed with government data due to privacy protections. Additionally, CHAS does not have a system in place determining who gets hired for what jobs and how they subsequently perform. CHAS is hopeful that there may be more government safety data available in the future. CHAS is also considering implementing better feedback loops between their host employers' contractor safety experience and the CHAS database on contractors. A potential roadblock in assessing effectiveness of stage 1 safety prequalification criteria in screening out unsafe contractors is the division in screening responsibility created by stage 2. It may be that failure to catch an unsafe contractor would be due not to an inadequacy in stage 1 criteria and implementation but rather an inadequacy in stage 2 procedures. thus, there may be a tradeoff between the economies of scale derived from breaking prequalification down into general and particular standards and the economies associated with tracking the outcomes of a unified system. Still, the fact that CHAS covers so many contractors and hosts offers the possibility of very large statistical samples where gauging the effectiveness of standards on outcomes is more feasible.

At this stage in its development, CHAS' approach to identifying best safety practices and setting corresponding standards is to communicate with host companies. CHAS believes that hosts know what they need and want, and that CHAS safety standards should reflect general notions of best safety practices based on host experience. Hosts, in turn, can implement specific criteria based on a risk assessment of particular work. CHAS believes that stage 1 and stage 2 can be used to scale prequalification

standards and costs to the risks of specific work by making stage 1 sufficiently general and scaled down as to apply to all work, making stage 1 a one-stop shopping experience for contractors where duplication and multiple standards are minimized, and making the standards in stage 2 (the host's responsibility) calibrated to the risk of the specific work on offer.[16]

The UK example provides considerable perspective for contractor safety prequalification in general. The proliferation of third-party safety prequalification services is much more developed in the UK compared to the US due primarily to the broader regulatory encouragement of prequalification practices. The advantages of size in safety prequalification services seen in the UK case provides some insight regarding how such practices might proliferate in the American market especially under the encouragement of regulation. The method by which prequalification is scaled to the safety risks of the work at hand by loading the general prequalification costs onto the service provider's contractors and the specific costs onto the host or those contractors specifically bidding on the host's work is one method of scaling. Alternatively, the host could ask the service provider to scale prequalifications based on specific host projects. This approach is found in some cases in the US. The UK also provides an example of inherent market pressures rooted in administrative economies of scale in prequalification to collectively determine core safety prequalification standards. However, as of yet, these standards are not informed by formal statistical analyses of safety outcomes under prequalification but rather on deductive notions of best practices informed by past experience and safety engineering principles. Potentially, with the growth and

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[16] This information regarding CHAS comes from a telephone interview with John Murphy, CHAS scheme manager, December 18, 2007.

consolidation of safety prequalification services in the UK, and modifications in privacy

rules, systems can be put into place that will supplement experience and engineering

views of correct safety standards with a statistical analysis of the effects of differing

safety criteria on workplace accidents and illnesses.


## *The Intersection of Pre-Qualification with the Model of Occupational Safety and Health*

### Model of OSH: Organizational Epidemiology

Reference was made in the introductory section to this chapter of the paradigm

shift toward an "organizational epidemiology" model of occupational safety and health

(OSH) from one that placed greater emphasis on technical controls. Such a model

acknowledges the importance of "organizational demographics" in occupational health

and safety, as well as the broader industrial and regulatory climate. Organizational

demographics include type of business (SIC code), firm size (number of employees), OII

rates, sales volume, type of ownership, affiliation with trade associations, profitability,

and net assets (Rosenthal, 1997a). Membership of a chemical manufacturer in the

Chemical Manufacturer's Association (CMA), for example, is tied to subscription to, if

not compliance with, CMA's process safety code (Rosenthal, 1997a) Such private

regulation could be an important instrument in reducing the risk of accidents.

A major tenet of the organizational epidemiological model is that the process

safety management system, and its integration into overall firm management, is central to

safety outcomes. Part of the challenge associated with understanding the prospects for

contractor safety prequalification in promoting occupational safety is in understanding

how prequalification would optimally be integrated into the firm's process safety management system. To our knowledge, no analysis to date has addressed this issue, but the literature on organizational epidemiology, coupled with an empirical research on contingent work and safety outcomes in the petrochemical industry summarized below, yields insight into facets of safety prequalification that may be of import under conditions of risk for low probability, high consequence events.

Much of the impetus for the shift in paradigm focus arose from a series of low-probability, high consequence events (LP-HC) in the 1970s and 1980s, often in the petrochemical industry. Each European Union (EU) country in the 1980s promulgated process safety regulations following the Seveso Directive (82/501/EEC), which was issued by the EU in 1982 following several high profile accidents in the 1970s (Rosenthal, Kleindorfer and Elliott, 2006). The emphasis on process safety regulation in the United States followed the 1984 Bhopal accident and Phillips 66 plant explosion and fire in 1989. The Clean Air Act amendments in 1990s required that both OSHA and EPA develop standards to enhance process safety. OSHA issued its process safety management standard (PSM) in 1992 and EPA's Risk Management Program (RMP) rule was finalized in 1996.

The early Seveso Directive as well as OSHA's PSM standard were considered to be primarily technical in orientation, and neglected critical features of the safety management process (Rosenthal, Kleindorfer and Elliott, 2006). After additional high profile accidents, a subsequent directive from Seveso was issue in 1996 (Seveso II) which focused more intensively on aspects of management in terms of process safety. Failures of the management system were seen to be a contributor in 85% of accidents. Annex III

of the Seveso II directive maintained that the process safety management system, in order to be effective, must be integrated into the general management system, and must stipulate the organization and procedures for prevention as well as  the roles and responsibilities of  personnel for management of, and training related to, major hazards. It also explicitly indicated the importance of involvement of employees as well as **subcontractors** where appropriate (emphasis added) (Rosethal, Kleindorfer and Elliott 2006).

Clearly, the new focus on process and away from technical controls over individual substances reflected a  direction for OSHA that squared well prior literature that suggested more generic standards that involved industry-generated  information  and guidelines would be productive in promoting safety, given the daunting task faced by the agency of regulating thousands of individual substances (Rosenthal, 1988).   The promulgation of the OSHA PSM and EPA RMP met with (overly) optimistic predictions of 80% reduction in accidents, an outcome, of course, that failed to materialize.   Rather than misidentifying the root causes of accidents in process system management, the failure to substantially reduce the incidence of LP-HC events has been viewed instead to reside with quality, that is, the absence of effectiveness in process safety management. Attention has therefore turned to metrics and instruments that would identify characteristics of effective safety process management (Rosenthal, Kleindorfer and Elliot, 2006).

Because of the rarity of LP-HC events, the development of such metrics poses a significant challenge, and it would be convenient if there was a tight correlation between more regular occupational illness and injury (OII) recordables and catastrophic accidents

associated with RMP (Rosenthal, Kleindorfer and Elliott, 2006). More likely, features of

safety management associated with lower OII may be necessary, but not sufficient to

assure reduced risk of LP-HC events. Furthermore, the liability environment is likely to

clash, in several instances, with the goals of effective information gathering, root cause

analysis, and ultimately, organizational learning (Rosenthal, 1997b). Extending data

gathering capacity in order to have sufficient power to conduct root cause analysis of LP-

HC events and identify critical metrics may require expansion of the databases of public

agencies, such as EPA and OSHA, and the U.S. Chemical Safety and Hazard

Investigation Board (Rosenthal, 2002; Rosenthal, Kleindorfer and Elliott, 2006). But

cooperation from industry in providing accurate information is essential, and may require

renewed attention to impediments against such cooperation in liability law (Rosenthal

1997b). If safety prequalification of contractors is to be effectively used as a tool beyond

traditional OII, and in reducing injuries and fatalities in LP-HC events, clearly the

features of process safety management that are associated with the risk of such events

need to be better understood.

Another dimension of sound management of safety under a model of

organizational empidemiology is the relationship of the firm to the larger community, as

the community is often subject to exposure through LP-HC events. Rosenthal (1993)

advises that such community relations be structured with the same seriousness of purpose

as that with government or with internal technical personnel. Community Advisory

Councils, which serve more than simply public relations purposes, but allow for public

input, information dissemination, and participation in the development of codes of safety

management practices, Rosenthal maintains, can be integral to process safety

management (Rosenthal 1993).   While not addressed in the literature, clearly such Advisory Councils, to the extent that they participate in general development of management practice, could logically play an integral role in the development of codes surrounding safety prequalification.

**Contingent work and injury in the petrochemical industry.**   No systematic published analysis has been conducted to date on the effects of safety pre-qualification on injury, but one study (Rebitzer, 1998) of the effect of contract work on injury in the petrochemical industry provides the most detailed insight to date into the characteristics of contract work, in an industry subject to LP-HC events, that are associated with workplace injury and that might be most fruitfully addressed in modeling safety pre-qualification.   Rebitzer's analysis relies on survey data from the John Gray Institute report, discussed above, made specially available to the author.   National survey data from that report reinforced that contract labor in petrochemicals was already an extensive phenomenon by the early 1990s:  32% of average production labor hours during non-turnaround periods, and 50% during turnaround periods were accounted for by contract employees (Rebitzer, 1998).

From the survey of three hundred managers conducted by the John Gray Institute, 76% reported having primary responsibility for the safety and health training of their contract workers, but over a third were not required to submit any information on their safety and health programs in order to bid on the contract.   The survey also found that many host employers do not collect information on the past injury performance of their contractors.  Of 243 plant managers providing accident data for their own employees, 101 could not provide such data on their contract employees (Rebitzer 1998).

The individual-level survey undertaken for that report provided additional data on contract versus direct hire employees in the petrochemical industry. The initial sample of 309 plants was taken from Dun and Bradstreet's list of petrochemical facilities. Beginning June, 1990, Louis Harris requested lists of direct-hire and contract employees who worked at 120 of these facilities in April and May of 1990. Individual employees were then contacted by telephone, with a final sample of 610 direct-hire employees and 623 contract employees. Individual response to the Louis Harris survey was well over 90%, but representation of plants was far lower and potentially creates sample bias; the percentage of plants responding was about 33% for direct-hire employees, and about 25% for contract employees. A variable, ACCIDENT was constructed to determine whether a respondent had an accident requiring first aid, treatment by a physician, or at least one lost day of work. Clearly, this variable did not capture aspects of accident severity that would be desirable, but results are still informative. The mean of ACCIDENT overall was significantly higher for contract than for direct-hire employees: 26% compared to 19%, respectively (Rebitzer 1998). But much of this discrepancy was due to the preponderance of contract employees in maintenance relative to direct-hire employees. Within maintenance, the rate of ACCIDENT was not statistically different between direct-hire and contract employees (Rebitzer, 1998); however, as noted below, low job tenure may have resulted in an underestimate of ACCIDENT among contract employees.

There were other significant differences between contract and direct-hire employees with respect to training, tenure, and demographic characteristics. Direct-hire employees received over twenty hours of safety training from the host employer, whereas contract employees received on average, about nine hours of training from the contractor

and three hours from the host (Rebitzer 1998).  Other significant differences were manifest in terms of job tenure, with direct-hire employees having significantly longer tenure.  Indeed, the large number of contract employees that were on the job for under one year meant that reporting on ACCIDENT for the previous year may have been significantly underestimated for contract employees (Rebitzer 1998).

Safety supervision was gauged as "close" in the survey if accidents, injuries or safety problems had to be reported to host management by contractors.   Host employers clearly sustained an arms length relationship to contractors in many instances, as only 28% of contract personnel had "close supervision", that is, were required to report such circumstances to host management.   This is a critical variable in the multivariate analysis, as discussed below

In terms of education and demographics, direct-hire employees had significantly higher education, and contract workers were younger and more likely than direct-hire employees to be Hispanic.  Not surprisingly, wages were higher among direct-hire workers, as was union membership.

A multivariate analysis was performed on ACCIDENT, strictly for those employed in maintenance jobs.  Findings indicate significantly higher risks of risk for contract workers with low experience, whereas the rate for those with more experience had a coefficient in the direction of higher accidents, but it did not meet the 95% confidence interval for statistical significance (Rebitzer 1998).  Close supervision by host was also found to be a robust and statistically significant factor in reducing accidents among contractors, by 21%.  In even fuller specifications, controlling for demographics, union affiliation, and extent of safety training by the host, close supervision by the host

was found to a robust predictor of safety outcome: close supervision reduced accident rates by 20% (Rebitzer 1998). This finding, among others results demonstrating a significant reduction of accidents associated with training by the host employer, but not job tenure, which may have been somewhat confounded by training and demographic variables, lends support to responses on the ORC and RMCOEH surveys undertaken for this project and summarized elsewhere in this report that suggests that safety prequalification may work best under circumstances where the host employer is actively involved, and where there is a large premium placed on the extension of safety culture from the host employer. The literature on safety management practices which are most effective in reducing accidents and injuries among direct-hire employees certainly place a premium on supervision, accountability, and safety culture (Manuele, 1997, Peterson, 1996). Clearly, if liability concerns encourage an arms length relationship of host employer to contractor employee with respect to supervision, training and culture, the risk of accidents and injury among contract employees is significantly higher. If safety pre-qualification, in order to be most effective, needs to work in conjunction with such active participation on the part of the host employer to be effective, rather than filling gaps created by a more arms length posture, as is suggested by the results of the ORC and RMCOEH surveys, then this literature bolsters this finding. Rebitzer notes that, along with the limitations of the data used in the survey, the findings could also reflect a certain selection bias: that plants engaging in close supervision, understanding their liability, may have a tendency to shunt contract workers to safer jobs within the plant. Thus, close supervision may not be fully responsible for creating a safer environment. While not perfect, the Rebitzer analysis provides the best evidence to date that contract worker

safety, relying on evidence for those working in maintenance in the petrochemical industry in 1990, are likely to benefit from safety prequalification to the extent that host employers are active in supervising and training safety of such workers.

As outlined earlier, however, the role that safety prequalification can play in reduction of LP-HC events, rather than the more routine OII that is the subject of the Rebitzer analysis, depends on further development of metrics and analysis of such events.

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# Chapter 2 An Analysis of the Effectiveness of Current Safety and Health Prequalification Practices

## *Match, Gap and Regulate: Why Host Employers Engage in Contractor Safety Prequalification.*

Traditionally, in the world of direct employment, the safety of the workplace was the direct responsibility of the employer. In a multiemployer workplace, however, responsibility for safety becomes diffused among the many employers on site. The host employer certainly retains both a moral and legal responsibility for the overall safety conditions of the work site, but because decisions regarding the direction of some or even much of the work devolve down to contractors and subcontractors doing the work, the host employer is not, and cannot be, directly involved nor directly responsible for all of the safety-related management decisions of all of the various contractors.

However, if the host employer cannot directly manage all of the safety-related decisions of the contractors on-site, the host can, nonetheless, when purchasing the services of these contractors, attempt not only to buy the needed services, but also to buy the safe delivery of those services. In the words of one host employer, safety prequalification exist to ensure that hosts "select contractors who are most likely to work in a safe manner."

Prequalifying contractors based on safety criteria, thus, is at its heart, an effort **to buy safety**. It is also an effort to send a signal to the contractor community that safety

capabilities are part of the specifications of the services being sought by host employers. This is often referred to as setting contractor expectations regarding safety performance. For instance, one host employer said that safety prequalifying was done "to help us set [contractor] expectations and manage risks. The resultant work outcome is reflected in the management systems required to run a safe operation." By setting contractor expectations, hosts expect that safety prequalification standards will bring the contractor community up to those standards over time. As one host put it: "safety pre-qualification gives the host company an indication of the contract company's safety culture. A positive trend in injury rates over time is an indicator of a progressive safety program." So hosts want to buy safety, and they want to find improved safety capabilities in the contractor market over time. Thus, safety prequalification procedures are **a market signaling device** that may have the effect over time of both setting and even raising the standards of contractor safety performance on the multiemployer work site.

Many host employers view safety prequalification as **a matching device** designed to align the safety capabilities and expectations of the contractor to the safety culture of the host employer. One host said that they safety prequalify "to ensure that we are contracting with companies that have similar EH&S [environmental health and safety] expectations." Another stated: "[We safety prequalify] to ensure [that] we are bringing on contractors that maintain the same safety values and practices that we do as a company, [in order to] minimize and/or eliminate injuries and property damage." In our survey of host employers asking them why they safety prequalify, the vast majority said "to align the contractor's expectations and safety culture with our own company's work and safety culture." The majority of those who did not list this as their top reason for

safety prequalification, listed this as their second reason. The second most common reason for safety prequalifying in our survey was "To align the contractor's capabilities with the specific inherent safety risks of the work they will be doing." Thus, safety prequalification can be thought of as **a method for matching safety cultures and aligning contractor safety capabilities with the host's safety needs**.

When contractor safety capabilities do not align with the host's safety needs, safety prequalification requirements can be part of **a safety gap analysis**—designed in the words of one host employer to "match available contractors with needed [safety] capabilities, [and to] identify gaps [between what is needed and what contractors are capable of in order] to create a safety mitigation plan." So safety prequalification can be part of a process of assessing the degree of contractor safety the market is able to deliver at any point in time, and a method for assessing how that squares with what the host needs on the job. If there is a gap between what is needed and what can be bought, then this becomes part of the host employer's risk assessment of the job and allows the host employer to formulate post-bid safety risk mitigation strategies. Often these strategies entail requiring the suspect contractor to have a full-time safety officer overseeing the contractor's work.

Additionally, safety prequalification is part of the host's due diligence in **meeting the legal and regulatory responsibilities** of the host in ensuring a safe work place. One host stated: "[Our] entire [safety prequalification] system has been developed….simply to ensure [that our company] has met its due diligence requirements." But most hosts wrapped the issue of regulatory compliance and due diligence into a larger philosophy of safety precaution. One host said they safety prequalify "to ensure contractors meet

required safety requirements before starting a project; to ensure contractors are able to pass [their] own H&S [health and safety] requirements, [and] to expedite, and to streamline the bidding and contracting process in regards to safety efficiency." Thus, for this host employer, safety prequalification not only helped ensure that both the host's and the contractor's regulatory requirements were met, but safety prequalification also streamlined the contracting process by making sure that those considered for contracts would meet these regulatory requirements in advance of the contract award. Most contractors, however, when addressing the issue of regulatory and legal standards, typically placed these concerns within a much broader view of the purpose of safety prequalification. For instance, one host said they safety prequalify "to promote a safe work environment for employees and contractors, to reduce or minimize hazards to employees and the environment, to provide financial protection, to ensure contractors' knowledge of applicable regulations, laws, and policies, and to ensure that the contractors meet the culture and performance expectations of our company."

This last account comes close to an overall statement of why host employers engage in safety prequalification of contractors. Hosts are trying to **buy** "a safe work environment" by setting prequalification standards. They are trying to **match** the contractor's safety "culture and performance expectations with our company." Hosts are trying to financially protect themselves by ensuring that contractors know the "applicable **regulations**, laws and policies." It only need be added that safety prequalification provides an opportunity for the host to determine whether they can buy what they want in the contractor market, and if not, safety prequalification helps hosts to focus on how to mitigate the **gap** between what they need in terms of a safe delivery of services and what

they can purchase.  **Buy, match, gap and regulate**—these are the four legs of the safety

prequalification stool.  But how effective are the current safety and health

prequalification practices in meeting these and other needs of the host employer?


## *Analysis of the Effectiveness of Current Safety and Health Prequalification Practices.*


There are two basic ways in which host employers safety prequalify contractors.

On the one hand, **solitary prequalification** entails a prequalification process undertaken

at the plant or company-wide level without the involvement of, or communication with,

other plants or other host companies.  The solitary unit (plant or company) develops its

own prequalification standards and procedures and places qualified contractors on its

own bid list.  In contrast to this single-plant or single-employer approach, there are two

**multi-employer prequalification** approaches.  First, in areas where there is a

concentration of similar host employers drawing from the same contractor pool, informal

or formal communication between these hosts allows for the development of shared

information regarding the safety history and capacity of contractors.   We will examine

the formal variant of this approach which historically has entailed the development of

local or regional safety councils. These safety councils marry the issue of contractor

prequalification with the issue of worker prequalification.  In so doing, area safety

councils exploit economies rooted in the need to both prequalify contractors and workers

but do so at the cost of being more tightly tied to location and industry.  Second, there has

emerged a contractor safety prequalification service industry which formally merges

through their services the contractor prequalification process across companies, across

plants within companies, and across regions.  These service companies exploit economies

rooted in the overhead administrative costs and auditing expertise of contractor

prequalification without a close regard for region or industry.  They do this at the cost of

not melding contractor prequalification with worker prequalification (e.g. drug testing,

safety training and testing, criminal background checks, etc.).  However, this dichotomy

is fluid, and to a certain extent both types of third party prequalification are taking on

some of the attributes of the other.  Here we will compare the advantages and the

disadvantages of solitary and multi-employer contractor prequalification in each of their

two variants.

## *Solitary Prequalification.*

In our survey, just over half of the respondents use the solitary approach to

prequalification.  In some cases, it is **a full-solitary** approach with each major plant

within the company doing its own contractor safety prequalification.  One health and

safety officer in a major manufacturing company told us that each plant has its own

safety prequalification program primarily because the various plants in the company have

distinct safety cultures which make melding their approaches to safety prequalification

difficult.  The different safety cultures are both the product of history and personality, and

plant safety culture differences are also due to different technological demands and safety

needs in different facilities.  Another health and safety officer in the petroleum refining

industry indicated that up until recently each refinery in the company had its own safety

prequalification program.  He approved of that approach because it allowed his refinery

to have greater control over the prequalification process, and he felt that under the

solitary system, his refinery had higher safety standards relative to other refineries within the company. Currently, his company is in the process of making uniform the prequalification procedures across refineries in the United States, and this safety executive felt that his refinery relaxed some of their auditing procedures in order to come in line with a company-wide standardized approach. Standardization is also often a process of compromise involving both raising and lowering prequalification requirements in response to other considerations. For instance, one plant within a company might require field safety audits every year while a second plant might require field audits every three years. Standardizing might entail field audits for all plants every two years in an effort to balance the benefits of field audits against their costs. A plant with one-year field audits regret this downgrading of the periodicity of audits if they felt the benefits of more frequent audits were justified by the local conditions in their contractor market. This is an example of the typical justification for the full-solitary approach.

One of the challenges in making safety prequalification uniform across plants in major, international corporations is the difficulties in standardizing across countries with the inherent legal and economic differences that entails. A second challenge in establishing uniform safety prequalification standards across plants in large corporations is the possibility that different plants are doing substantially different things with correspondingly substantially different contractor needs and substantially different contractor constituencies. The third challenge is variation in corporate safety cultures across plants within a company rooted in the history of those plants, including when they may have come into the company, and where the plants are located and what they are doing. All of these factors encourage a local-control full-solitary approach to safety

prequalification. Other factors lead towards the proliferation of a general and more standardized approach to safety prequalification across plants within a company.

One factor leading towards a more uniform approach across plants within a company is a learning-from-colleagues phenomenon which leads to a progressive upgrading of safety prequalification procedures throughout the company. One safety professional in a manufacturing company recounted how one plant within their company implemented safety prequalification procedures because of regulations that applied to that plant but not others within the company. Nonetheless, the usefulness of safety prequalification became evident and led to emulation in other non-regulated plants within the company. A second factor tending towards a more company-wide uniform approach to prequalification is software. Safety prequalification is, among other things, a gathering of information. Because information is computerized, either in-house or third-party software is needed to record, store and retrieve this information. Software requires a standardized approach to recording and retrieving information, and once this system is put in place, there are substantial economies of scale in using that software. So even in plants with substantially different safety cultures or distinct contractor communities or varying regulatory environments or unique production technologies, software has a tendency to bind the information gathering process together within the uniform demands of the software itself. This may help overcome some of the demands for local control of safety prequalification, but also through local modifications of the software, some local control may be preserved. A third factor that can shift a company away from local control of safety prequalification towards a company-wide approach is a more generally uniform overall managerial approach within the company. Some companies are more

top-down than others, and these companies are more likely to have a top-down approach

to safety prequalification. A fourth factor in using a company-wide approach is

economies of scale in safety prequalification—not only software and administrative

economies but importantly also, in the not uncommon case of plants within a company

sharing a contractor community, economies of scale in not having to prequalify

contractors multiple times. As one executive told us: "Internally across the entire

company, sites can review the pre-qualification forms of other sites, thus no longer

requiring the contractor to complete forms multiple times." These various factors can

combine to encourage a company-wide approach to prequalification. For instance, a

health and safety executive form a very large company told us: "We have [safety

prequalification] as part of our governance that for all contractors who perform work that

needs our managed system to manage them that they be prequalified. [We have] an

extensive contractor pre-qualification program that has been digitized." Thus, safety

prequalification can be an integral part of a broader management system controlling a

very large corporation that is facilitated by software economies of scale and justified

often in its ability to reduce the incidence of prequalifying contractors multiple times.

Typically, however, in our interviews, we found in many cases a mixture of local control

and top-down approaches to safety prequalification. Sometimes the uniformity of

approach was broader than the plant but not company-wide, with one region or set of

plants moving towards a single approach while other regions and other plants took a

somewhat different approach. Other time, a corporation would set broad general

standards but local plants could vary the details under which these standards were

implemented. Thus there is not a bright white line drawn by the dichotomy between the

plant-solitary and the company-solitary approach to safety prequalification. Rather there is an evolving structure of local and corporate control. Nonetheless, our interviews suggest that the over-time tendency is to move upward from plant safety prequalification to larger units within the company rooted both in the economies of prequalifying a contractor only once and the economies of fixed administrative and software costs. These upward tendencies are slowed by the uniqueness of local contractor markets, local safety requirements and local safety culture.

The major advantage of either the **plant-solitary** approach and/or the **company-solitary** approach is complete host-control of safety prequalification. This allows for a tighter integration of the plant or company's broader management systems and its safety culture with the safety prequalification process; and it gives the plant or company a strong sense of ownership of and therefore commitment to the prequalification process. As one health and safety executive told us: "We use our own [safety prequalification process] as it is the best system in North America." This is clearly a matter of pride of ownership, and it also may be seen as a proprietorial competitive advantage. Some corporate executives indicated that their safety record was an important input to their corporate reputation and in turn, they felt their corporate reputation for safety and quality were major proprietorial competitive advantages. However, while unique local conditions, sense of ownership and proprietorial advantage all encourage a decentralized approach to safety prequalification, economies of scale in the sharing of information push in the opposite direction. Safety prequalification is expensive in terms of time, administrative costs, contractor costs and the potential loss of qualified and safe contractors unable or unwilling to bear some of the costs associated with safety

prequalification. Sometimes the market can ease the cost of a local approach by providing software that reduces some of the administrative costs of safety prequalification. For instance, one informant told us: "We have taken [safety-prequalification] in-house, using [a third party] software to collect the data." To the extent that the third party software is customizable to the distinct and unique characteristics of the company or plant, companies can solve, or at least mitigate, this cost associated with local control of safety prequalification. Nonetheless, the same scale-economy-pressures that tend to push safety prequalification away from the local plant towards corporate headquarters (such as everyone using the same third-party software and/or reciprocity across plants so that contractors only have to prequalify once) tends also to push safety prequalification outside of the company, itself, towards multi-employer safety prequalification procedures.

## *Multi-employer Prequalification.*

**Local area safety councils** are non-profit corporations that combine contractor safety prequalification with worker safety prequalification. In order for this to work there must be a locationally concentrated set of host employers who share both a pool of contractors and a pool of workers moving between those contractors. This typically means that the host employers are within the same industry. Also for the area safety council approach to work, it is helpful if there is not too much leakage of trained and tested prequalified workers out of the local labor pool. Local safety councils provide drug testing, criminal background checks and safety training-and-testing for the pool of workers which the pool of contractors taps. The area councils also safety prequalify the

contractors, themselves.  Because there will always be more workers than contractors to safety prequalify, and because worker turnover in-and-out of the area and in-and-out of the industry can be high, the costs of safety prequalifying workers can be high.  To the extent that worker turnover is lower for whatever reason, this cost is mitigated.  As one of our informants indicated: "Regional safety councils are very helpful for the standardization of safety training expectations [of both workers and contractors] and the sharing of [contractor] performance data."  Another health and safety professional stated: "[We] love cooperative skills training, security background checks and work-load leveling [across host employers and contractors] to share common work force pool."  Nonetheless, host employers did worry about the issue of worker retention.

The primary reason local or regional area safety councils are local and/or regional is because they are engaged in safety-qualifying a shared local labor pool as well as safety prequalifying a shared contractor pool.  This contractor community also has to have strong local characteristics.  Ultimately, the geographic rootedness of the labor and contractor pools is due to a geographic concentration of like host employers who share a demand for these contractors and laborers.  It is an exaggeration to say that this is a closed system, but analytically it is useful to think of it as such.  Area safety councils are exploiting the potential economies of scale associated with this concentration of host employers, contractors and workers.  Therefore, to a significant extent, the safety councils themselves become locationally rooted.  Training and testing centers have to be built locally, computers put in place so workers have a place to go to be trained and tested.  In addition to a rootedness in location, local area safety councils are rooted in an industry.  Because they are exploiting the economies of scale in worker safety training

associated with a shared pool of workers, these local area safety councils develop an expertise in particular types of safety training.  As nonprofits, these safety councils have boards which may be composed of contractors, host employers, and third parties drawn from the local community.  Thus, area safety councils tend to take on the cultural rootedness of the trustees in an area or an industry or both.

But the rootedness of area safety councils can be overstated.  Some of the things they do, such as criminal background checks, may be useful screening information country-wide.  Also, a fair amount of safety training need not be industry specific but rather hazard specific, thus having applicability broader than the industry in which the area council may be historically rooted.  Furthermore, some worker testing, such as drug testing, may be subcontracted to more general drug testing companies, and thus not require that the area council have its own local drug testing facilities.  Finally, with the advent and ease-of-use of the internet, safety training and testing facilities may not need to be the fixed buildings and computers they once were.  Just as universities are developing distant learning capabilities, so might regional area councils develop distant training/testing capabilities.  But also, just as universities confront problems with monitoring tests in a distant-learning context, so do area safety councils face these problems.  The point here is that local area councils, while historically rooted in an industry and location, are nonetheless evolving entities with the potential for geographic and industrial-sector expansion.  However, the problem of worker leakage increases as the area safety council becomes less defined by industry and location.

Additionally, even though the safety council may have prequalified only local contractors and workers, those contractors and workers may together travel outside the

region to do work.  This may give the information that the council has gathered additional value outside the region.  Furthermore, even though to an considerable extent, various local area councils compete with each other when the pool of contractors and workers they prequalify overlap regions, local area councils can also cooperate with each other in the sharing of information and the administering of tests.  This reciprocity in training, testing and information sharing gives the area safety councils a broader geographic reach.

The general point is this:  local area safety councils exploit economies of scale in the testing, training and prequalifying of workers and the safety prequalification of those workers' contractors.  This has historically emerged where there were concentrated pools of both industry-specific workers and contractors within a local area.  By setting standards for training, testing and prequalifying that are accepted by a collection of local host employers, the local safety council sends a strong market signal to both workers and contractors regarding the safety expectations within the industry and location in which they seek work.

As suggested above, there are some downsides to this effort at training a local pool of workers.  As one host said, they "use safety councils for training but question [worker] retention."  The safety training of workers is costly.  Local safety councils allow local host employers and contractors to share the cost of safety training workers they share. This eliminates repeating the same training and duplicating this cost.  This is not unlike the economies associated with not duplicating the safety prequalification of contractors.  But on the other hand, if the trained worker leaves the local labor pool either by leaving the area or leaving the industry, then from the perspective of the hosts and contractors, excess training expenses have been incurred.  The solution, in principle, is to

make the worker pay for his own training, drug testing, criminal background check, etc. However, indirectly the contractor or host may end up paying for these prequalification procedures through higher wages or the inability to make the local safety council successful strictly on the revenues from workers who may not have sufficient funds to pay for all their own training. Some hosts limit their use of the services of a local safety council. One stated: "A local contractor/safety organization is used more for high level contractor requirements and drug screening." This limits the use of the council to key contractor safety prequalification requirements that are mission crucial and to a worker screening criterion that cannot be solved by in-house training. The other tasks the council might serve, the company does itself. So just as you find mixed cases between plant and company-wide solitary prequalification, you get mixed cases in the use of safety councils vs. solving the safety prequalification problem in-house. As we will see, mixing and matching approaches can get even more complex.

**Safety Prequalification Service Providers.** Over the last decade or so there has emerged a private, for-profit service sector industry in safety prequalification. These companies provide levels of services including: 1) dispensing, collecting and disseminating PQFs (safety prequalification forms), 2) validation of the information in the PQFs, 3) office audits where the contractor's office is visited and various executives are interviewed and further information gathered and/or validated, and 4) field audits where contractor work sites are visited, foremen and workers are interviewed, and again, further information is gathered and/or validated. Not all service companies provide all these levels of services, and not all hosts order the full range of services. And obviously, the cost of contractor prequalification rises as the prequalification services are extended.

In simple terms, area safety councils tend to more fully exploit economies of location while for-profit prequalification service providers tend to more fully exploit economies of information. For the most part, prequalification service providers do not engage in worker training or worker prequalification, and these companies are not as closely rooted to one industry or one location. By specializing more specifically on contractor prequalification but not focusing on workers or a particular locationally concentrated industry, safety prequalification providers can serve a wider geographical and industrial market. What these service providers have to sell is safety information gathering and auditing expertise, plus the economies of scale associated with contractors being able to go through the safety prequalification process once and becoming prequalified for multiple host employers across regions and even across industries. This economy of scale differs from the economies of scale exploited by area safety councils to the extent that the hosts for which the contractors are prequalified are in different areas and/or industries. So, again keeping things simple, a contractor who prequalifies through an area safety council becomes multiply qualified for a variety of hosts within the same industry and area. A contractor who qualifies through a safety prequalification service company may become multiply prequalified for hosts in a variety of industries or hosts within an industry but in a variety of areas. Not doing worker training and worker prequalification, and not being historically dedicated to one industry, allows for-profit, safety-prequal service companies to exploit this different dimension of the economy of scale associated with multiple host qualification through one prequalification process. Solitary company or plant approaches to safety prequalification cannot tap this economy to nearly the same extent. If the solitary company has multiple plants, then multiple-plant

prequalification is possible. When hosts informally share information about contractors with other hosts, this is a step in the direction of trying to capture more of the multiple-host-qualification economy of scale. But in general the solitary company approach is least able to capture this economy; the area safety council is more able to capture this economy, but the for-profit prequalification service company is best situated to capture scale economies associated with one process qualifying the contractor for multiple hosts.

Prequalification companies nonetheless customize their prequalification process to the needs and demands of the host employer. For instance, one prequalification company sets up its software so that if one host wants only a PQF and validation and a second host wants additionally an office and field audit, the contractor will be subject to all four levels of prequalification but the first host only has access to how the contractor fared on the first two levels of prequalification while the second host will see all four results. Safety prequalification companies face similar dilemmas of standardization that solitary companies face in trying to standardize across plants. Safety prequalification companies seek to mitigate the costs of standardization through flexible software protocols. We will discuss further the challenges of customized vs. standardized approaches to safety prequalification in the next chapter of this report.

It needs now to be mentioned that things are not always as simple as they have been represented here. Historically, safety prequalification service cpmpanies have tended to specialize in serving specific industries; often industries that were regulatorily required to safety prequalify contractors. So there is more rootedness in safety service companies than one might think. One the other hand, safety prequalification service companies can create alliances with local drug testing companies and/or worker training

and/testing companies creating a hybrid between a general safety prequalification service company and a local safety council. So safety service providers are not as much specialists in contractor prequalification only as one might think. Area safety councils, in turn, through reciprocity agreements with other local councils and through the travels of contractors and workers who they have prequalified, can reach across geographical areas and effectively uproot aspects of their rootedness. So in competition with each other, area safety councils and contractor prequalification service providers attempt to poach on each other's specialties.

We also find host companies mixing and matching the products of area safety councils, prequalification service providers and in-house safety prequalification. One executive told us: "We use a contractor to screen and make sure all the data is completed on the questionnaire. [Our company] ultimately approves or disapproves contractors." Another stated: "[We] use safety councils for common training …[and] use a third party service for data collection but not [contractor] rating." Another company indicated that they use two geographically separated area safety councils, and two different prequalification service providers—one for some of their plants and another for a second set of the company's plants. Geography explains the use of two area safety councils and history explains the use of two prequal service companies. Some plants within the company began with the first service company and other plants started up with the second prequal company. So far, in this host company, the potential economies associated with standardizing with one safety prequalification company have not been sufficient to break this historical pattern.

The service sector in safety prequalification is a work-in-progress with the two sides of the industry evolving towards each other in pursuit of the multiple-host-prequalification economy of scale available through these third party providers that is not as easily tapped by the go-it-alone approach of solitary plant and solitary company safety prequalification. As contractor and labor markets merge across industries and across regions, these multiple-host-prequalification economies will become more important and area safety councils will have to take on more of the characteristics of the safety prequalification companies to follow those merging markets. To the extent that contractor and labor markets remain geographically, industrially and even company distinct, then the multiple-host economy of scale will be less important and the strategy of combining contractor prequalification with worker prequalification will be more feasible.

One last point—to fully exploit the scale economy of multiple-host-prequalification, ideally there should be only one contractor safety prequalification company. There is not and consequently, contractors sometimes or even often have to safety prequalify through separate prequalification-company procedures. This, of course, raises the cost of safety prequalification. On the other hand, there are economies associated with innovation driven by competition. Service providers competing with each other are motivated to innovate and improve their product, streamline their procedures and reduce their costs. The benefit of competition among service providers must be balanced against the benefit of multiple-host-prequalification through one service provider. Like so much else in the world of contractor safety prequalification, the industrial structure of the contractor prequalification industry is a work-in-progress.

Whether as this industry matures an optimal number of service providers emerges that nicely balances the benefits of competition with the benefits of economies of scale remains to be seen.

### Economies of Scale and Depth in Contractor Safety Prequalification

**When Is Multiple-Host Safety Prequalification a True Economy?** Multiple host prequalification is the major justification for third party safety prequalification. Multiple host prequalification saves money for both the host and the contractor. It shares the cost of prequalification across the host employers (and their customers through the price of the hosts' products), and it reduces the cost of prequalification by not requiring contractors to prequalify multiple of times. These are not economies of scale to the extent that the contractors do not serve multiple hosts. Multiple host prequalification through a third party also shares the administrative overhead cost of safety prequalification across hosts. Computer costs, software costs and other fixed costs of safety prequalification are reduced per contractor prequalified to the extent more contractors are prequalified. One safety-prequal service provider we interviewed had 3000 contractors on its list of prequalified contractors and one area safety council had 1500 contractors. A go-it-alone plant or company might have considerably fewer prequalified contractors on its bid list, and consequently face higher fixed costs in safety prequalification per contractor. These overhead costs are less important to the extent the host is, itself, very large with large numbers of contractors on its prequalified bid list, and this economy of scale might be otherwise captured if safety prequalification can be piggy-backed on top of other contractor prequalification processes that would be done

anyway. So multiple-host safety prequalification provides economies of scale savings for companies with shorter bid lists, larger pools of contractors from which they draw, fewer captive contractors, and a more limited set of other contractor prequalification procedures.

**International Contractor Safety Prequalification.** Globalization has created an additional challenge to safety management and a new potential for economies of scale in contractor safety prequalification. As one health and safety executive at a major international corporation put it: "Safety prequalification in countries outside the United States is more difficult, and safety performance information is harder to collect." Another international corporation executive we spoke with indicated that on a world-wide basis, more than 50% of their on-site workers were the employees of subcontractors. A second international manufacturing corporation indicated that around 5% to 10% of their workforce worldwide was the employees of contractors. On the one hand, contractor safety prequalification in a global context face challenges associated with differing regulatory environments, differing availability of information regarding contractor safety history, dramatic differences in the structure, breadth and depth of the contractor community, differing general awareness of safety issues, differing availability of safety equipment, differing levels of skills across local labor markets, differences in computer and telecommunication infrastructure, and differences in cultural approaches to questions of safety. The ease or difficulty of contractor safety prequalification is affected by all of these factors.

On the other hand, many international corporations seeking to globally manage contractor safety in a multiemployer context are interested in at least a minimal general

standard for prequalifying contractors based on safety. Often, these companies seek to implement a minimal company-wide, international standard and piggy-back locally-based standards on top of that. We know of at least one instance where one international corporation is in discussions with one safety prequalification service provider to explore ways of implementing third party safety prequalification on an international basis starting with the United States and Mexico and expanding from there. So both contractor safety prequalification and third-party service provision of safety prequalification are evolving not only in response to the evolving structure of the contractor and labor markets in the United States, but also in response to the evolving needs of international host employers in a globalized world.

**Levels and Periodicity of Prequalification.** How far down the hierarchy of safety prequalification a host company goes in its own procedures, or a safety council or a safety-prequal company goes, and how often the various stages of the prequalification process are repeated, depends on the concerns of the host employer, the standardization required by company-wide approaches or the usage of third party prequalifying service, and the costs of safety prequalification.

In most cases, the direct cost of prequalification is born by the contractor, but indirectly, the host can pay for prequalification if these costs become reflected in the price of bids host employers receive. Also, in the case of third-party safety prequalification service providers. (both area councils and prequalification companies), it is possible for the service provider's fee structure to share out direct costs between the contractors and the host, either at any given stage of the prequalification process, or by

charging the contractor for the earlier stages, but charging the host for the later, more detailed stages of the prequalification process.

Too much attention can be paid to the question—who pays?  Ultimately, the customer will pay as the costs of safety prequalification move from the contractor community through bid prices to the host employer community to the eventual consumer through the pricing of the final product.  In this economic arbitrage, the question of who benefits also comes into play.  The price of the final product, the costs to the host, and the bid prices of the contractors, need not necessarily go up due to safety prequalification. They may well also go lower if safety prequalification leads to a safer workplace and worker compensation costs fall, production interruptions associated with accidents are reduced, and other economic benefits of a safer workplace enter into the equation.

Nonetheless, how far down the prequalification process service providers go is proximately determined by the concerns of the host, and the costs of safety prequalification to the host and the contractors.  All other things being equal, doing a deeper, more thorough safety prequalification of contractors is better in terms of safety, but this must be balanced against the time, administrative and direct costs of prequalification, the risks and potential severity of workplace accidents, and the benefits of reducing or eliminating those accidents.  As one executive stated: "[Safety prequalification] takes a lot of time but if you don't put stringent requirements in place, you get what you pay for."   Another executive put it: "[Safety pre-qualification] does add costs to the job but has been worth it based on our experience.  It helps to deliver a good quality finial product to us and helps keep worker compensation costs down (including premiums) for the contractor."

**Contractors, Subcontractors and Layers of Prequalification.** One executive told us that his company "has a very simple philosophy regarding safety prequalification...ALL contractors (including subs) must be pre-qualified." Unfortunately, this is easier said than done, and the difficulty of prequalifying subcontractors is directly proportional to how many layers of subcontracting are on the host site, and how rapidly subcontractors come onto-and-off the job.

The subcontracting problem is particularly challenging in construction. Construction users have long recommended the safety prequalification of subcontractors. Most of the largest construction companies have at least some form of subcontractor safety prequalification. The establishment by owners of prequalified bidders lists based on a variety of performance criteria is increasingly common in construction. However, these prequalified bidder lists typically refer to a list of general contractors who bid to the owner(host). Usually in construction prequalified lists of contractors do not include subcontractors. A prequalified general contractor may bid on the work this time with one set of subs and bid on the project next time with another set of subcontractors. So prequalifying the general contractor does not directly prequalify any one subcontractor or set of subcontractors. Furthermore, teams of subcontractors are put together quickly. As one general contractor told us (and we paraphrase)—"the owner/host-employers often has 30 days to put together a request for bids, and I often only have three days to put together my bid. I do not know who my subs are until I see their bids. I do not have time to prequalify them for the owner/host-employer."

With some exceptions, general contractors serve a fairly wide range of owners/host-employers. Again, with some exceptions, general contractors use a shifting

set of subcontractors. Furthermore, with some exceptions, construction work is awarded in an open-bid process that puts a premium on low bids. The pressure on general contractors to pare down bid prices quickly through the selection of a shifting set of low-bid subcontractors turns the general contractor plus his subs into a shape-shifting entity that is difficult to accurately safety prequalify for work on the host's site. In the case of isolated new construction, host companies may be tempted to simply excuse themselves from attempting to manage host-site safety because the construction work will not impinge on the safety of the host's employees or endanger the host's property. But where the construction is either new construction adjacent to on-going host work, or renovations of host facilities while host work proceeds, safety risks to the host's workers and facilities are ever present. Some form of safety prequalification may be needed. Needed as it may be, safety prequalification of subcontractors in a construction context is very difficult.

In one group interview that included a host employer, a general contractor and one key subcontractor who commonly worked for the general, it emerged that the general, who often worked for the host, was safety prequalified by the host, and the sub, who commonly worked for the general, was safety prequalified by the general, but at the next layer of subcontracting, the safety prequalification process broke down. The sub did not prequalify his subs.

Hosts can enforce subcontractor prequalification by not allowing any non-prequalified subcontractor onto the host's worksite. But this sort of enforcement may be costly. When a subcontractor is not admitted, and construction work shuts down until a prequalified sub can be found, or the barred subcontractor can be prequalified,

tremendous costs can occur from the mere interruption of work.  This bar-the-door sort of enforcement takes the "pre" out of prequalified and can be costly to all parties.  Effective safety prequalification must, in general, have effect prior qualification of contractors and that is very difficult in the case of subcontractors in construction.

## *The Prequalification-Procurement Tradeoff.*

> "Nearly all contractors [at this major international company] are prequalified based on safety.  Exemption of contractor prequalification has been completed for emergency response situations, geographically remote work areas, and international locations.  Certain types of contractors not performing work considered safety sensitive (clerical, consultants, couriers, etc.) are also excluded."

From a moral perspective, no one should have to worry about getting hurt at work or dying on the job.  From an economic perspective, the risks of an unsafe performance by contractors, along with the risk that they not perform the job on time, along with the risk that they may do a poor job, all have to be balanced in a scale that has on the other side the cost the contractor charges for the work.  Where the safety risks are high, the scale tips in favor of a more rigorous, time-consuming and costly safety prequalification processes.  Where the time cost or money cost of prequalification is high, the balance tips towards making an exception to prequalifying contractors or to lowering the standards of safety prequalification.  There are four cases where we have found that companies were willing to subordinate safety prequalification to time and cost considerations in the procurement process.

**Emergency Contractor.**  Sometimes an unexpected contractor need emerges from the host's production process.  An unexpected repair, an unanticipated cleanup, an

immediately needed new type of machinery, anything where time is of the essence and the need was unforeseen presents the possibility that the host needs a contractor type that has not be previously safety prequalified. Because the "pre" in prequalification recognizes that safety qualification takes time, an immediately needed activity that was not foreseen faces the host with heavy time costs that may not justify safety prequalification particularly if the safety risks are not overly high and/or if some other sort of safety risk-management technique is available such as requiring a special safety officer be hired by the contractor to oversee the work.

**Monopoly Contractor.** Some contracted work is easily foreseen but in the area where the work is needed, there is only one or perhaps a limited number of recalcitrant contractors who can do the work, but they are not inclined to go through safety prequalification procedures. The emergency contractor may be willing to be safety prequalified, even willing to adjust his procedures to become safety prequalified, but there is not enough time to get the prequalification done. In the monopoly contractor case, there is time. The need is foreseen. But the available contractors are unwilling to cooperate, there is no regulatory requirement to force them to cooperate, and because they have a strangle-hold on the service in the area, they do not need to cooperate with safety prequalification. Most prequalification procedures have an exception for the monopoly contractor similar to the emergency contractor sometimes calling for some sort of on-site safety risk-mitigation such as a safety officer and/or a specific safety plan for this contractor.

**The Contractor on Safe Work.** No work is completely safe, but the risk of injury or death varies by job as does the possibility of hurting others as does the

possibility of damaging property.  In our interviews, office services, janitorial services, food services were typical activities that might be exempted from contractor safety prequalification.  Facility operations were the least likely to be exempted.  Furthermore, to the extent that safe work was near to dangerous work or in some other way entangled with dangerous work or exposed to the mishaps of dangerous work, then even though the work was, in itself safe, contractors were less likely to be exempted from safety prequalification procedures.

**The Cheap Contractor.**  Some work in some environments is primarily driven by direct costs.  The work may have few direct or indirect safety risks.  The work may not have any safety prequalification regulatory requirements.  The work may be in a segment of the host's operations that is cost sensitive for a variety of competitive reasons.  Here safety prequalification may take a back seat to direct costs.  Examples of work that may have little safety risks again might be office, food or janitorial services.  Work that might be particularly cost sensitive might entail products with highly price elastic demand, perhaps products exposed to overseas competition or a large number of local competitors.  Under these circumstances, whole segments of the host's onsite work might be exempted from the entire safety prequalification process.

**How Many Contractors?** Prequalifying contractors based on safety usually means that some contractors will not qualify.  In our survey, host employers reported that on average, around 15% to 20% of all contractors failed to pass the safety prequalifications.  This limitation on the number of bidders for any one project may affect the accepted bid price raising (all other things being equal) the cost of the contracted work.  However, as will be discussed more extensively later on in this report,

if prequalification standards are widespread, most contractors will eventually come up to speed on safety performance limiting the number of contractors who are excluded from bidding on safety prequalified work. Nonetheless, to the extent that coming up to safety standards entails costs, those costs will become embedded in the prices contractors offer on prequalified work.

In the sort run, there are two simple rules to assess the effects of limitations of the number of bidders on contractor bid prices. The first is the rule of diminishing marginal impact. The most change in competitive pressure any one contractor will feel in the bidding process is when a second bidder has entered the list. Now the first contractor's monopoly has been eliminated. A third bidder puts pressure on the first two and a fourth bidder puts pressure on the first three. Progressively, each additional bidder adds an ever diminishing increment to the competitive pressure on the bid price. So the first rule is that additional contractors have progressively weaker impacts on the bid price. The second rule states that as the opportunity cost of losing the project rises, the competitive pressure of each additional bidder on the other bidders rises. Here the issue is how badly does the contractor wants the work? If the job is particularly large, or work elsewhere is particularly scarce, or if for any other reason, the opportunity cost to the contractor of losing this job is high, each contractor will invest more in assessing the true cost of the work. When the opportunity cost of losing the bid is high, each contractor will be less inclined to pad his bid. When the job is worth winning, all contractors "sharpen their pencils." Thus, the second rule is, when the host employer takes an attractive job to market, he does not need as many bids to get a competitive price.

So how many contractors are needed to get a competitive bid? For a run of the mill job, five or six would be nice, three or four would be doable. For a job that contractors really want, three or four bids will work well, and even two might be sufficient if the job is attractive enough.

**Summary of the Safety-Procurement Tradeoff.** The safety –procurement tradeoff is key to understanding the level of rigor in contractor safety prequalification. Some companies address this tradeoff by simply not failing any contractor based on safety standards. As one host put it: "[Our safety prequalification process] does not eliminate any contractors from the bid process as the decision to hire these contractors is based mostly on cost and ability to provide the service." Most of those we interviewed, on the other hand, go in the opposite direction—requiring safety prequalification of all contractors and then making exceptions for the emergency, monopoly or cheap contractor and exempting work that is deemed safe and separable from riskier areas of work.

Our survey analysis showed that contractors were less likely to fail if they were on the host's worksite for less than six months. (Equation 11) This reflects the prequalification-procurement tradeoff in two ways. First, some short-term contractors are not so integrated into the host's work process as to be exposed to significant risks. One example of this is the "maintenance" contractor who came periodically but briefly to replace the tires on the host's vehicles. Second, the cost of prequalifying closely and deeply short-term contractors is high for the time they will be on site. So hosts probably do not set as high a standard below which contractors fail in the case of short term contractors compared to long term contractors.

Our survey analysis also showed that 70% of responding host employers said that their most important reason not to prequalify contractors is that some work poses little or no safety risks. But, in considering work that does pose safety concerns, 50% of respondents indicated that they might not safety prequalify contractors if it restricted the number of available bidders. However, once the emergency contractor and the monopoly contractor are handled through ad hoc safety mitigation procedures, the issue of limited number of bidders is itself limited as long as the host has three or more bidders on desirable jobs and (say) four or five bidders on average jobs. Nonetheless, for some companies, the issue of procurement and restricting bidders is sufficiently important that safety prequalification is not a standard below which a contractor might fail but rather an input among many others regarding the characteristics by which a contractor might be judged.

In our interviews we did not encounter the use of "best-value" bidding in the safety prequalification process. Best value bidding is a formal point system which assigns a point value for the contractor's price and point values for other factors such as reputation-for-quality, on-time performance and safety. The contractor with the highest points summing across price, quality, timeliness, safety and other factors wins the job. When the host tells us that "The environmental health and safety pre-qual is just another bit of information [in the procurement process] but would not necessarily eliminate a contractor if they met the cost and service ability criteria," to us that says the host is using an informal best-value bidding process that weighs, in each instance, the relative importance of safety against other procurement issues.

Indeed, pass-fail and best-value are alternative approaches to placing safety into the procurement process. Hosts can set a safety standard below which contractors fail, or hosts can establish a point system allowing contractors can compete for work trading off price against performance against safety and against other factors. Most hosts do the latter informally. Best value techniques simply formalize and standardize how these competing factors are weighed against each other. The pass-fail system has the virtue of setting safety clearer standards for the contractor community to meet and perhaps over time the clarity of these standards will delineate a path of safety improvement which all contractors will follow. A formal best-value approach more flexibly weighs the safety-procurement tradeoff but might not send as clear a market signal regarding desired safety standards. These issues will be discussed in greater detail in a subsequent section of this report.

## *Match, Gap and Regulate Redux .*

> "The prequalification process is simply an upstream tool in identifying the risk of using certain contractors. It is successful when other aspects of safety are utilized such as a strong safety planning and site orientations on safety performance expectations. Together the process creates an understanding of the site expectations of an injury free work environment which is the worthy outcome of the efforts invested."
>
> --Executive at a major international corporation

> "Our Canadian sites pre-qualify contractors because of regulatory requirements to do so in Canada. In the US, it is left up to the hiring personnel and EHS to determine if a pre-qual is needed."
>
> --Executive at another major international corporation

In the beginning of this chapter we argued that safety prequalification was implemented to match the host employers safety needs and culture with the contractor's

safety capabilities and culture; that safety prequalification served the analytical purpose

of revealing to the host any gaps between the safety needs of the company and the safety

capabilities of the contractor community; and finally that safety prequalification was, in

some cases, a response to regulation. In our discussion of emergency and monopoly

contractors, we provided specific instances in safety gap analysis. Safety prequalification

provides a formal exposure of the gap between company needs and contractor capabilities

when the emergency contractor has not prequalified and the monopoly contractor cannot

or will not prequalify. By seeing this gap, hosts can mitigate the risk that it exposes

though other means. But here our main emphasis is on how regulation and culture-

capacity matching can reinforce each other.

The Occupational Safety and Health Administration (OSHA) and the

Environmental Protection Agency (EPA) mandate process safety management (PSM) for

industries using hazardous chemicals. OSHA encourages and rewards Voluntary

Protection Programs (VPP) inside and outside of industries where hazardous chemicals

are used. VPP in turn, requires PSM and thus diffuses PSM into the wider economy.

Both PSM and VPP require contractor safety prequalification thus diffusing safety

prequalification practices within the economy. PSM also stimulates the development of

modern safety cultures. This tends to make safety prequalification not just a setting of

standards but ideally, a marriage of safety cultures.

PSM focuses on process safety, operational safety, worker training and also

importantly worker involvement in safety awareness and promotion. Taken together, the

emphasis on these four factors tend to focus safety evaluation on process safety

management capabilities, safety and health management systems and worker

involvement, and focus less on more traditional individual behavioral safety characteristics. As shown in out survey analysis, the single most important reason hosts give for safety prequalifying contractors is "to align the contractor's expectations and safety culture with our own company's work and safety culture." Individual worker characteristics are secondary to this overarching goal. PSM and VPP regulations reinforce and diffuse this view of safety management.

## *Summary.*

In this chapter, we have shown that current safety prequalification practices reside at the plant level, the host company level, in area safety councils and through the services of safety prequalification companies. We have shown that the location of safety prequalification at the plant level, company level or in third parties reflects a balancing of the benefits of safety prequalifications that are customized to the needs of a specific plant or company with the benefits of allowing contractors to prequalify one time for multiple plants or hosts. We have described the structure of prequalification as a work-in-progress with a variety of mix-and-match approaches that seek to capture the benefits of both customization and economies of scale.

We noted that the two types of prequalification service providers exploit different economies of scale with nonprofit area safety councils focusing on the dual safety prequalification of contractors and workers by exploiting economies of location while the for-profit safety prequalification companies focus on a broader range of areas and industries in order to more fully exploit the economies of information.

We argued that the shape of proliferation of safety prequalification across the economic landscape is driven not only by corporate managerial policies and the competition of safety prequalification providers, but also by globalization and the increasing importance of worldwide safety risk management for the international corporation.  International companies are experimenting with the implementation of contractor safety prequalification internationally and service providers are tentatively exploring the possibilities of serving this need.  This is the most challenging new area of contractor safety prequalification.

We argued in this chapter that at the heart of safety prequalification is the prequalification-procurement tradeoff.  This tradeoff can be addressed by setting safety standards and then exempting selected activities and/or contractors.  Or this tradeoff can be balanced by an informal or formal best-value point system that weighs, in each case, the relative value of contractor safety capabilities against contractor price and quality offerings.  We hinted that the former approach may provide a stronger market signal stimulating an improvement in the safety capabilities of the entire contractor community.

We mentioned that construction work is particularly challenging.  Given the rapidity with which construction general-contractor-subcontractor teams are assembled, and reassembled, it is difficult to prequalify downstream subs especially as the layers of subcontracting multiply.  In a later chapter we will suggest some possible solutions for this problem.

We also provided a rule of thumb for understanding how the number of contractors affects the prequalification-procurement tradeoff.  You do not need eight, nine or ten prequalified bidders to get a competitive bid.  The law of diminishing returns

indicates that the tenth bidder does not add much to the competitive pressures of the market. The law of opportunity costs also indicates that if the job is attractive to contractors, all other things being equal, you need fewer bidders to get a competitive bid.

Finally, we noticed that regulations requiring contractor safety prequalification tend to emphasize what the hosts themselves emphasize as important—safety culture and safety expectation alignment is the key goal of contractor safety prequalification. But how do you identify and align safety cultures? Can past safety outcomes indicate current safety culture? Can prequalification forms and paper documentation reveal enough about safety culture for the alignment to be calibrated? We turn to these and related questions in the next chapter of this report.

# Chapter 3 An Analysis of the Critical Attributes that When Incorporated into Prequalification Standards Are Most likely to Enhance the Safety Performance of Contractors

## *The Context for Selecting Key Contractor Characteristics*

Safety prequalification of contractors might be thought of as a formalized courtship designed to make the marriage of two companies' safety cultures work. Courtships obviously do not ensure that marriages will work. Nonetheless, finding out about the other person, laying out expectations, agreeing to make some adjustments going in, getting a sense of the other's history, all enhance the prospects that a marriage will work and a business partnership will work. But just like a marriage cannot be made to work simply through an effective courtship, on-the-job safety in a multiemployer context cannot be made to work simply through an effective safety prequalification program. Many safety and health executives at host companies reminded us as the following executive did:

> "The prequalification process is simply an upstream tool in identifying the risk of using certain contractors. It is successful when other aspects of safety are utilized such as a strong safety planning and site orientations on safety performance expectations. Together the process creates an understanding of the site expectations of an injury free work environment which is the worthy outcome of the efforts invested."

This characterization of the safety prequalification process as a tool, the effectiveness of which will hinge on how it is integrated into a firm's process safety management and safety culture, is integral to the organizational epidemiological model of

OSH described earlier in Chapter 1 (Rosenthal, 1997a). Key attributes to the success of safety prequalification schemes may differ depending upon whether the primary goal in its deployment is reducing relatively high frequency injuries that would lead to recordable OSHA illnesses and injuries (OII), or whether it is to support the reduction of low probability high consequence events that would be reportable to authorities under RMP regulations.

There is an extensive literature which demonstrates that OII, resulting from accidents such as slips and falls, is responsive to, and can be reduced by, concerted efforts by the firm to elevate the importance of safety management within its culture (Rosenthal, Kleindorfer and Elliott, 2006). Dramatic declines in OSHA recordables per 100 employees, for example, were garnered by General Motors and Fort Dearborn in the months following an elevation of priority accorded to safety within the culture of those firms (Rosenthal, Kleindorfer and Elliott, 2006). The relatively high frequency of OII enables a firm to concretely track safety performance, which bodes well for metrics such as OSHA log and lost workday injury data in informing the safety prequalification process. Fatalities that are directly correlated with circumstances that lead to OII would also logically be reduced.

The rarity of LP-HC events, on the other hand, raises potential difficulties with relying on OII performance to predict the risk of such events. Aspects of process safety management may share an important thread leading to both OII and the risk of RMP reportable accidents, but the incidence of OII may, in itself, be a poor proxy for such risk (Rosenthal, Kleindorfer and Elliott, 2006). Because management generally responds to what is measured, the literature would suggest that the range of metrics incorporated into

safety prequalification may be critical to its usefulness in reducing the risk of RMP accidents in addition to OII. This is not a concern for industries, or even parts of firms or plants within a given industry, that are not susceptible to catastrophic and high profile events. But, prequalification may need to be part of a more intrusive, ongoing evaluation and audit of features of process safety management (PSM) in order for a reduction in fatalities associated with LP-HC events to transpire Instruments, such as the ProSmart tool developed for the chemical industry for evaluation of critical features of PSM, and "near miss" data, may add important dimensions to safety prequalification for reducing the risk of LP-HC events (Rosenthal, Kleindorfer and Elliott 2006). The nature of metrics are important, of course, but so is the quality of data. It is well known that OSHA log data is often incomplete. Process safety management data may be critical to risk evaluation for RMP recordables, but collection of data under ProSmart, as an example, is apparently quite resource intensive (Rosenthal, Kleindorfer and Elliott 2006). Aside from cost in data collection, incentives to collect accurate data may be influenced by liability (Rosenthal, 1997b) and employee confidentiality (Rosenthal, Kleindorfer and Elliott 2006) concerns.

It follows that effective contractor safety prequalification is an often a necessary, but never a sufficient condition for establishing a safe multiemployer workplace. Within this clear limitation, here we ask the question—what works? What are the critical contractor-attributes that when incorporated into prequalification standards are most likely to enhance the safety performance of contractors? But we will see that this question can only be asked and answered in the context of the specific work that the contractor will be doing, and a determination of the economic sweet-spot created by a

tradeoff in the predictability of good-but-expensive information against cheap-but-only-general information about the contractor's safety prospects.

In this chapter we argue that hosts need to weigh a contractor's past safety history against the contractor's current safety capacities. The host will also need to decide the relative importance of individual worker and managerial attributes, training and experience against the contractor's overall safety management system. Some of these things we can only talk about in principle. Others we have uncovered specific measures allowing us to subject them to rigorous statistical analysis. Ultimately, that which is easier to measure must be combined with that which is hard to measure in order to formulate an effective safety prequalification system.

Furthermore, contractor characteristics (past vs. present; behavior vs. system) have to be put in a work context the general dimension of which are three: 1) whether the contractor and the contractor's workers are going to be on the host site a short period or a longer period; 2) whether the contractor is going to be at the center or on the periphery of the safety dangers of the worksite; and 3) whether the contractor is going to use subcontractors or self-perform the work.

Also, the host will have to decide how far down in the prequalification process the host and/or the contractors are willing and able to go. Some contractor attributes may be critical but difficult to ascertain. Other attributes may be only generally useful information but inexpensive to obtain. How good is cheap information? How far does the host have to go in order to get good information? Finally, the host will have to determine how often the prequalification process is to be repeated for both long term contractors and periodically returning contractors. And safety-prequalification

periodicity has to be determined for each level of prequalification as the investigation

drills deeper down into the contractor's operations.

So to answer the question—What are the critical contractor-attributes that when

incorporated into prequalification standards are most likely to enhance the safety

performance of contractors?—there are layers of context needed. First, safety

prequalification is only effective within a broader safety management plan including

project risk assessment information provided to contractors and contractor site-

orientation. Second, the characteristics placed in the prequalification standards will have

to take into consideration the broader context of the contractor's envisioned work—not

only whether the contractor will be at the center or on the edge of the project's safety

risks, but also whether the contractor will be on-the-job briefly or a long time, and

whether the contractor will be bringing subcontractors on the job. Third, and derivative

of the safety context and work context, but determined also by many other factors, the

critical contractor-attributes needed in the prequalification standard will be partly

influenced by the economically feasible depth and periodicity of prequalification, and an

optimization of a tradeoff between cheaper-less-predictive and expensive-more-

predictive information about the contractor.

In addition to context, in asking the question—What are the critical contractor-

attributes that when incorporated into prequalification standards are most likely to

enhance the safety performance of contractors?—we must consider two outcomes. First

is the selection outcome. What key contractor attributes lead to the selection of safety

contractors to the exclusion of less safe contractors? Second, is the improvement-over-

time outcome. What contractor attributes when placed into prequalification standards

more generally will lead to improved safety performance by the contractor community in general?  Enhanced contractor safety performance in the short run is a matter of selection and in the long run it is a matter of stimulating improvement through past selections.  We will be looking for prequalification standards that select the best and change the rest.

## *Is the Past Predictive of the Future or Do Contractors Learn from Their Mistakes?*

In our interviews with, and surveying of, health and safety executives at major American corporations, in general, our respondents thought that contractor safety prequalification works.  But doubts were also raised.  For instance:

> "The benefit of new firm "qualification" is over sold – [there is] no direct correlation between high rating [in safety prequalification] and performance on projects."

To examine this possibility, we gathered data, from a safety prequalification service company, PICS, that serves a variety of host employers in several industries including petroleum refining, chemicals, manufacturing, power plants, and consumer service companies.[17]  The data have approximately 3000 contractors in their data base with at least three years of safety indicators for each contractor.  This company provides four layers of safety prequalification drilling down from 1) the filling out and verification of a prequalification form, 2) an audit of the contractor's safety manual which when "closed" means that the contractor has provided in written form all of the programs and policies required by the host employer.  In the company's jargon, this is called a

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[17] www.picsauditing.com

"desktop" audit, 3) a field-office audit geared at assessing contractor management systems, and 4) a field-workplace audit geared to assessing the implementation of safety procedures at the workplace.

| General Contractors | 246 |
|---|---|
| Electrical & Instrumentation | 142 |
| Engineering | 100 |
| Consulting (other) | 74 |
| Environmental Management/Remediation | 72 |
| Mechanical | 71 |
| Inspection Services | 67 |
| Field Maintenance | 56 |
| Air Conditioning/Refrigeration | 44 |
| Cleaning (Industrial) | 40 |

**Table 2: Largest 10 categories of contractors in the data**

Table 2 shows the largest 10 categories of contractors in the data set. These 773 contractors shown in Table 2 represent approximately one-fourth of all the contractors in the data. The first question we wish to ask these data is: do past reported injuries of a contractor predict current reported injuries by that contractor?
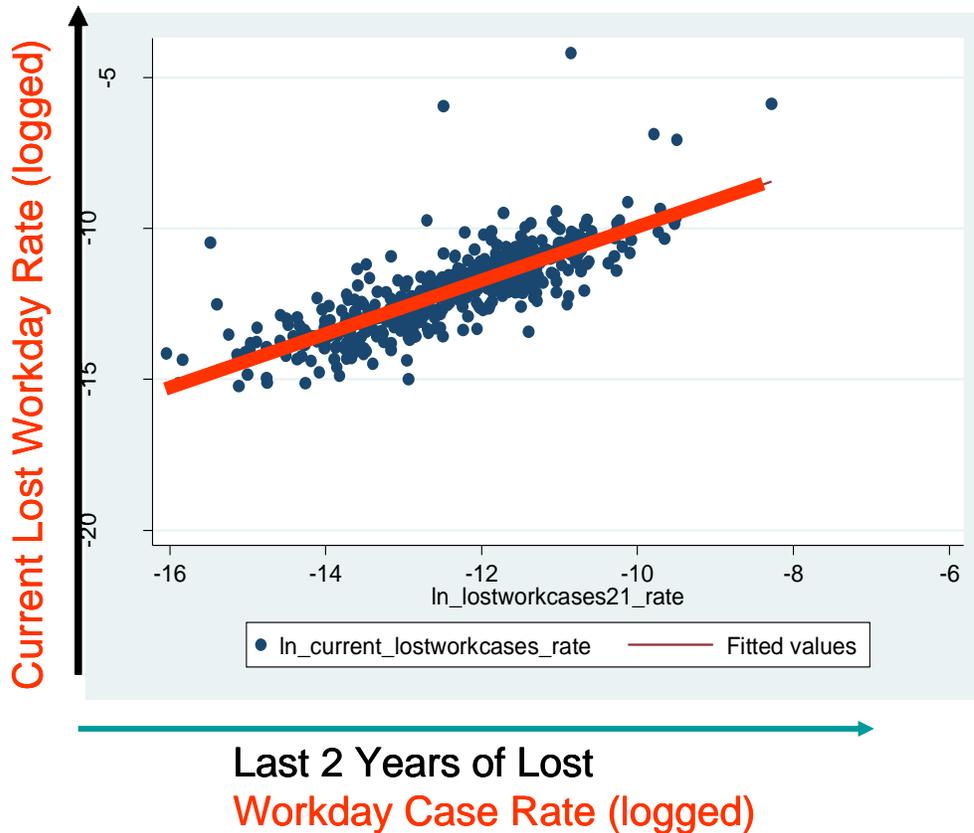
**Figure 1: Past lost workday injury rate predicting current lost workday injury rate**

A simple linear regression (the line in Figure 1) relates the average past two years of lost workday injury rates for a contractor to this year's lost workday injury rate. Because both sides of the relationship are logged, the slope of the regression line is an "elasticity" which in this case equals .87. An elasticity here means that in picking between two contractors, if the host chose one contractor with a 100% higher past-lost-workday-injury-rate compared to another contractor, the host can expect that the chosen contractor will have an 87% higher current-lost-day-injury rate on the host's site going forward compared to the contractor not chosen. The relationship in Figure 1 is not perfect (all the observations are not on the line itself and the elasticity—the slope of the

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line—is not one) but the connection is actually pretty tight and the relationship (standing at .87) is really strong. This means that there is, quite possibly, a direct and almost 1-to-1 correlation between potentially inexpensive-to-obtain safety prequalification standards and safety performance on the project. Readers should know that investigators have not generally been able to find the tight correlation between past safety records and current safety performance that we find in the data. However, past research on this issue has not been able to isolate records strictly for the contractor community as we have in using the PICS data. The specific relevance of our data to the question at hand may account for the statistical revelation of the connection of past safety outcomes and current safety results. Nonetheless, more research on this needs to be done to replicate and confirm this result.

If such research is done, it may be done better than we have by focusing data strictly on safety outcomes on host worksites. The data allows us to focus on contractors but it does not allow us to focus on contractor performance strictly on multiemployer sites that engage in safety prequalification. One of the final recommendations of this Report will be that better informational feedback loops be developed so that the data on safety prequalified contractors' performance be focused sharply on safety prequalified work. The data we have does not currently do this. When we look at the application to a contractor of various safety prequalification standards in the data, what we will be able to measure is the resulting safety outcomes for that contractor on all of that contractor's work whether it has been safety prequalified or not. This is a weakness in our data. Nonetheless, when we find statistically significant and meaningful effects of safety prequalification (as we do below), the effects are actually more impressive than the statistics suggest. For safety prequalification to have an effect that shows up in data

coming from both safety prequalified work and other work means that either the effect on the contractor's prequalified jobs is so strong that it is moving overall averages, or that by passing prequalified standards, the contractor has improved his safety both on and off prequalified work.

**Equation 1: Ordinary least squares multiple regression predicting contractor lost workday rates based on severity of past injuries, past lost workday rate and the number of prequalification requirements**

| Source | SS | df | MS |  |  |
|---|---|---|---|---|---|
| Model | 98.3455386 | 3 | 32.7818462 |  |  |
| Residual | 34.6437912 | 110 | .314943557 |  |  |
| Total | 132.98933 | 113 | 1.17689672 |  |  |

Number of obs = 114
F( 3, 110) = 104.09
Prob > F = 0.0000
R-squared = 0.7395
Adj R-squared = 0.7324
Root MSE = .5612

| Log Lost workday rate | Coef. | Std. Err. | t | P>\|t\| | [95% Conf. Interval] | |
|---|---|---|---|---|---|---|
| Log( Past # of days away) | -.0732816 | .0439542 | -1.67 | 0.098 | -.1603886 | .0138254 |
| Log(# PQF requirements) | -.1630697 | .0663624 | -2.46 | 0.016 | -.2945844 | -.0315549 |
| Log Past workday rate | .9284832 | .0549648 | 16.89 | 0.000 | .8195558 | 1.037411 |
| _cons | -.3745224 | .7447087 | -0.50 | 0.616 | -1.85036 | 1.101315 |

In Equation 1, we present an ordinary least squares regression model predicting the log of the contractor's current lost workday rate based on 1) the *severity* of past injuries experienced by the contractor as measured by the log of <u>the average number of days lost</u> per lost workday injury, 2) the *rigor* of the contractor prequalification process as measured by <u>the log of the number of prequalification requirements</u> listed in the prequalification document, and 3) the *momentum* of the contractor's safety habits as measured by <u>the log of the contractor's past lost workday rate</u>.  Due to the use of

logarithms and due to missing data among the various explanatory variables, the sample size falls to 114 contractors.  (The log of zero is undefined eliminating from the model any contractor for which a variable is zero—for instance, reporting zero lost workday cases for this year or in the past).

The results in Equation 1 are interesting.  First, momentum—the log of the past lost workday injury rate continues to be strongly associated with the log of the current lost workday injury rate.  Controlling for the severity of past injuries, and the rigor of the current prequalification process, the elasticity relating past injuries to the present is both tight and slightly stronger than that shown in Figure 1.  Here a 100% increase in past injuries for a contractor leads to a 93% increase in the current lost workday injury rate.  However, a doubling of the *severity* of past injuries as measured by the log of days lost per injury leads to only a 7% decline in the current lost workday injury rate.  The magnitude of this effect, while relatively small, is nonetheless (at least marginally) statistically significant—meaning we know the effect is probably there even if it is small.  The interesting thing about this severity effect is that it is *negative*.  This suggests that contractors learn from their mistakes or more accurately from the severity and cost of their mistakes.  However, this result is statistically significant at only the 10% level, the lowest level of statistical significance generally accepted in these matters.  So maybe contractors (or some contractors) do not learn from past mistakes.  One also might interpret the fact that the momentum effect is less than one as a learning outcome.  The .93 suggests that contractors today only experience 93% as many injuries as they did in the past perhaps because they are trying to reduce the number of injuries they have experienced.  Taken together the -.7 severity effect and the +.93 momentum effect say

that the past predicts the present, for the most part, but contractors also do learn from their past mistakes.

Additionally, contractors do seem to respond to the demands of safety prequalification. Doubling the number of safety prequalification requirements in the prequalification process leads to a 16% decline in the contractor's current lost workday injury rate. Note: this does not mean that hosts are selecting the safer contractor. In these data, we do not know whom the host selected. Furthermore, the injury rates in these data are for contractor work on host sites that prequalify and host sites that do not prequalify. What this result means is that when contractors are exposed to more rigorous safety prequalification process anywhere, they appear to clean up their act everywhere. (Or alternatively, the prequalification effect on prequalified sites is so strong that it shines through even when averaged across prequalified and non-prequalified work.). In either case, in Equation 1 we find that prequalification rigor induces improved contractor safety performance. Notice that this is an improvement result and not a selection result. We do not know from these data whom the contractor selected. What we know is how the contractor has responded to being subjected to prequalification standards. Equation 1 is a learning equation. The contractor has strong safety momentum from the past but it is not a perfect one-to-one correlation suggesting that the contractor is trying to reduce his injuries. If the past injuries are severe, the contractor tries even more to reduce his injuries, and if the contractor has to jump through prequalification hoops, the contractor tries to reduce his current injuries even more. Prequalification standards when implemented also may make it so they contractor can reduce his injury rate more.

**Equation 2: Same model explaining current lost workday rate as in Equation 1 with the addition of the number of past fatalities in the last two years**

| Source | SS | df | MS | | | |
|---|---|---|---|---|---|---|
| Model | 99.1283902 | 4 | 24.7820975 | | | |
| Residual | 33.8609397 | 109 | .310650823 | | | |
| Total | 132.98933 | 113 | 1.17689672 | | | |

Number of obs = 114
F( 4, 109) = 79.77
Prob > F = 0.0000
R-squared = 0.7454
Adj R-squared = 0.7360
Root MSE = .55736

| Log current lost day rate | Coef. | Std. Err. | t | P>\|t\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| Log lost days per case | -.0662192 | .0438798 | -1.51 | 0.134 | -.1531874 | .0207491 |
| Log # of PPQF require. | -.1618253 | .0659133 | -2.46 | 0.016 | -.2924632 | -.0311874 |
| Log of past lost day rate | .9155899 | .0551898 | 16.59 | 0.000 | .8062055 | 1.024974 |
| Number of past fatalities | -.0746213 | .0470067 | -1.59 | 0.115 | -.167787 | .0185444 |
| Constant | -.5439105 | .7472734 | -0.73 | 0.468 | -2.024982 | .9371611 |

The issue of learning from past mistakes is revisited in Equation 2 which simply repeats the model in Equation 1 with the additional variable—the number of fatalities that the contractor had experienced in the previous two years. In this sample, there was, on average, about one fatality for every four contractors in the previous two years. Most contractors reported zero fatalities and one contactor accounted for 11 out of the 30 fatalities in this sample. The results for the other variables in Equation 2 are quite similar to those in Equation 1, except the addition of fatalities has weakened the statistical significance of the effect of the severity of injuries measured by the average number of days lost per case. (We would expect severe injuries and fatalities to be correlated and in Equation 1, it appears the severity of injury measure was picking up some of the effect of past fatalities on current contractor behavior. This is now controlled for with a separate fatality variable in Equation 2). The effect of a fatality in the past is to lower the reported current lost work day rate in the present. There is a 7% decline in the current lost

workday rate for every fatality the contractor experienced in the previous two years. In a separate test of standardized beta coefficients, the effect of our severity of past injuries measure and our fatality measure on the current injury rate are about the same with the rigor of the prequalification process having about a 50% stronger influence on current injuries compared to either of these "learning" measures from past injuries or fatalities.[18] Thus, this model suggests contractors learn from their past mistakes, but also contractors either learn from the safety prequalification process or at least, modify their behavior because of the safety prequalification process.

One implication of this finding that contractors learn from the past is that the past is therefore not likely to be fully predictive of the future. Many safety and health executives we spoke to felt that past fatalities were the single best predictor of present contractor safety risks. As reported in our chapter analyzing our survey of health and safety professionals at major host corporations, 40% of respondents indicated that past fatalities was the single most important predictor of current contractor risk of serious injuries, fatalities or otherwise catastrophic accidents. Less than 20% felt that lost workday injury rates were the most important past indicator of present performance, and less than 20% felt that experience modification rates were the most important predictive indicator. The reason respondents rated fatalities as the key indicator from past performance is because fatality incidents cannot be as easily under-reported or

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[18] Some readers may be concerned with the lack of statistical significance at the 10% level or better for the two "learning "variables (past injury rates and past fatalities) in Equation 2. This, in our opinion, is due to the limited number of observations and the fact that serious injuries and fatalities vary together. The same accident that results in a fatality may well also result in serious injuries. Because injuries and fatalities run together, in a limited sample, it is difficult to test the independent statistical significance of these correlated explanatory variables. An F test of the joint statistical significance of the two variables taken together indicates a joint significance probability of 8%--significant at the more relaxed conventional standard of 10% but not statistically significant at the 5% level. This implies our results regarding learning from past mistakes are suggestive but require additional research for strong confirmation.

misclassified or manipulated as can serious injury rates, or severity of injury measures, or worker compensation experience modification rates (EMRs). Lost day injuries can be transformed into light duty injuries. Days away from work can be reduced by return to work policies. Experience modification rates can, themselves, be modified by altering the report of the injury and/or misclassifying workers. Fatalities are not so easily misclassified, rearranged or under-reported. Thus, in practice, many host safety personnel focus on fatalities in screening contractors. In our sample, they would have focused on excluding or examining more closely the limited number of firms who had fatalities, no doubt paying particular attention to the contractor with 11 fatalities. But independent of the fact that non-fatal measures of past performance can be manipulated is the fact that contractors learn from the past and therefore the past is not entirely predictive of the present/future.

If contractors learn from the past, then host employers are facing a market of reformed sinners today. So how much can the past be said to be prologue for the present and how much is the past simply a learning experience?

Standardize beta coefficients for Equation 2 give us at least one answer to this question. Standardized betas tell us the relative impact of independent variables on the dependent variable in a model—in this case, current lost workday injury. Our four variables—severity of past injuries, past fatalities, current prequalification rigor and past injury momentum—have the following beta coefficients shown in Table 3

|  | Beta Coefficients |
| --- | --- |
| injury severity | -0.07 |
| fatalities | -0.08 |
| prequal rigor | -0.13 |
| past injuries | 0.87 |

**Table 3: Beta coefficients from Equation 2 giving the relative impact of learning through past mistakes (severity and fatality), responding to prequalification rigor and past injury momentum on current injury rates**

Equation 2 can be thought of as modeling contractor safety behavior as learning from the past and momentum from the past. The beta coefficients from Equation 2 help us measure the relative impact of learning from momentum. While, as discussed, the data suggest that past serious injuries, past fatalities and going through a rigorous safety prequalification process all result in lower current injuries, nonetheless, adding all these effects together yields -.28 while the momentum effect of past injuries leading to present injuries yields a +.87, an effect that is more than three times as large. Put another way, in balancing past performance as a learning experience vs. past as prologue, Equation 2 suggest that roughly 25% is leaning and 75% is same-old-same-old.

In our interviews with health and safety professionals at major host corporations, we were repeatedly told to be cautious—that contractors learn and current capacity for meeting safety standards is a better predictor of future safety outcomes. The results from Equation 2 are partially supportive of this view. There is evidence that contractors learn from the past. Also, there is evidence that contractors learn from going through the safety prequalification process. But there is also evidence that the heavy hand of the past sits upon contractors.

One conclusion here is simply, if the contractor does have high past lost workday injury rates, the buyer should be aware. But a second conclusion here is that contractors

as a group may ramp up their safety capacities over time not only in response to past bad experiences but also in response to current safety prequalification standards. Because our measure of current safety outcomes is not specific to worksites of host employers applying those safety prequalifications, the safety response to prequalification rigor may be even stronger than that shown in Equation 1 and Equation 2

## *Do Safety Prequalification Processes Separate the Wheat from the Chaff?*

From the data that we were provided, we do not know which contractors qualified for which host employers. Different hosts have different standards, and the same host can have different standards for different jobs. So among those contractors who complete their prequalification form and supply the necessary documents so that the information on their form can be verified and further provided their safety manual and had the information in that safety manual confirmed, we do not know (given the data we were provided) which of those contractors go on to become fully prequalified with what number of hosts. But we do know that those contractors who fail the first two steps—that is, they submit a prequalification form but have had trouble providing the supporting documents for that form and/or they provided a safety manual but could not confirm that it covered all of the procedures required by the host—are contractors who will not be "activated" and will not become safety prequalified. So we know, at least, the initial winnowing of contractors. Are the safety characteristics of contractors who get to first and second base different from those who strike out at the beginning?

| | Number of Contractors | Total Injuries and Illness Rate | Restricted Cases Rate | Lost Workday Cases Rate | Fatality Rate |
|---|---|---|---|---|---|
| **Have not closed desktop audit** | 751 | 3.72E-05 | 3.75E-07 | 3.11E-05 | 5.81E-09 |
| **Closed desktop audit** | 1031 | 1.33E-05 | 2.83E-07 | 8.87E-07 | 3.05E-10 |
| Statistical Significance | | 9% | 19% | 10% | 3% |

**Table 4: Current injury rates by increasing severity and by whether or not the contractor's supporting documents for the prequalification form have been supplied and confirmed**

In Table 4, injury rates are presented in increasing measures of severity—total injuries and illnesses, restricted-work injuries, lost-workday injuries and fatalities. Contractors are presented by those that have not completed their desktop audits and those that have. Completing a desktop audit entails submitting a safety prequalification form and then supplying the supporting documentation that confirms the information in the prequalification form, providing a safety manual and a PICS determination that the safety manual meets the host's requirements. This is a more relaxed level of safety prequalification than subsequent office audits and field audits which go past an examination of documents. Nonetheless, contractor current injury experience statistically divides by whether or not they are able to complete their desktop audits. In the case of each injury measure, the rates are higher for contractors who have not completed their audits. (The rates are presented in scientific notation with the "-0x" indicating the number of zeros to the right of the decimal point. Thus, while in the third column, 8.87-07 may appear to be a larger number than 3.11-05, there are in fact two additional zeros to the right of the decimal point before 8.87 meaning that it really is almost two orders of magnitude smaller than 3.11-05). Furthermore, in all cases except restricted workday

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case rate, the difference between the higher rate for contractors who have not closed out their desktop audit and those that have is statistically significant at the 10% level with the difference in fatality rates being statistically significant at the 5% level. Recall that the desktop audit is a less restrictive prequalification level. Yet it is separating the more safe from the less safe contractors. We conclude from this that safety prequalification does indeed separate the wheat from the chaff in the contractor market, but this still begs the question, what precise criteria are best in separating the safer from the less safe contractor?

## Which Is a Better Predictor—Lost Workday Injury rate or Worker Compensation Experience Modification Rate?

In our survey of health and safety professionals at major host employers, we found that while almost 40% felt that the most important past-performance measure of future safety outcomes was past fatalities, almost 20% felt that the past lost workday rate was the best predictor and an equal almost 20% felt that the past worker compensation experience modification rate (EMR) was the best predictor of future safety. Again in our data, we can see why professionals were equally divided in their assessment of lost workday and EMR rates as alternative predictors of contractor safety.

Last 2 years avg. lost workday case rate (logged)

Last 3 years avg. EMR rate (logged)
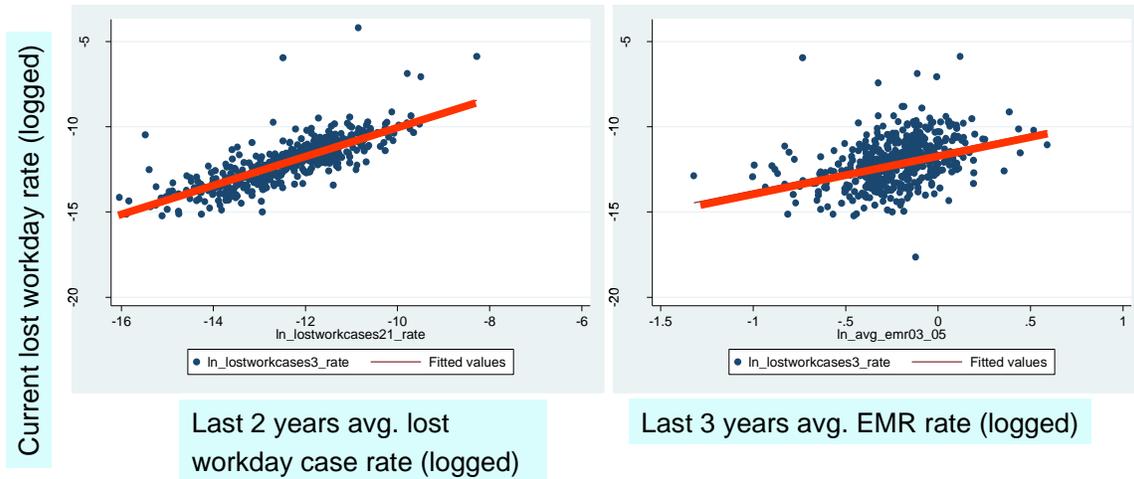
**Figure 2: Current lost workday injury rates predicted by (alternatively) the average of the last two years of lost workday case rate and the average of the last 3 years of the contactors workers compensation experience modification rate**

Figure 2 shows the simple ordinary lest squares linear regression line cast through

the scatter graph relationship between the alternative predictors—lost workdays and

EMR's—and the dependent variable—the current lost workday rate.  All variables are in

natural logarithms.  Because both the independent variables and the dependent variable

are logged, the slope of each regression line is an elasticity—a percentage change in the

independent variable will lead to a percentage change in the dependent variable. Readers

should notice three things about Figure 2.  First both regression lines are positively

sloped meaning that an increase in past lost workday rates or past EMR's will lead to an

increase in the current lost workday injury rate.  Second, the scatter around these

regression lines are tight indicating that the relationships are statistically significant.

Third, the graph on the left has a tighter spread and a steeper slope relating the last two

years of lost workday injury rates to the current lost workday injury rate compared to the

scatter and slope in the right hand graph for EMR's.  This means that the connection

between past lost workday injuries and current lost workday injuries is stronger than that

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of past EMR's to current lost workday injury rates.  But can these predictors be used

together?

**Equation 3: Ordinary lest squares regression model explaining the log of the current lost workday injury rate by the log of the past three years of EMR's and the past two years of lost workday injury rates**

| Source | SS | df | MS |  |  |
|---|---|---|---|---|---|
| Model | 464.076776 | 2 | 232.038388 |  |  |
| Residual | 222.856882 | 370 | .602315898 |  |  |
| Total | 686.933658 | 372 | 1.84659585 |  |  |

```
Number of obs =      373
F(  2,   370) =   385.24
Prob > F      =   0.0000
R-squared     =   0.6756
Adj R-squared =   0.6738
Root MSE      =   .77609
```

| log lost workday rate | Coef. | Std. Err. | t | P>|t| | [95% Conf. Interval] | |
|---|---|---|---|---|---|---|
| log past EMR rate | .5563763 | .1915695 | 2.90 | 0.004 | .1796747 | .9330778 |
| log past lost workday rate | .8628116 | .0348055 | 24.79 | 0.000 | .7943702 | .9312531 |
| constant | -1.291064 | .4224624 | -3.06 | 0.002 | -2.121792 | -.4603352 |

Equation 3 shows a linear regression model explaining the current lost workday-

case injury rate using both the past three years' average EMR rate by contractor and the

past two years' average lost workday injury rate by contractor.  Both independent

variables are statistically significant positive predictors of current injuries.  The adjusted

R-square of .67 says that two-thirds of the overall variation between contractors in

current injury rates is explained by the two measures of past safety outcomes.  However,

the impact of past lost workdays on current lost workdays is stronger—double the rate of

past lost workday cases and current lost workdays are point-predicted to rise by 86%.

This point prediction falls within a 95% confidence interval of 79% to 93% meaning with

only a 5% chance of being wrong, the true relationship between past and current lost

work rates is between an elasticity of .79 and an elasticity of .93.  In contrast, the point

prediction of the effect of past EMRs on current lost workday rates is a lower 56% and the 95% confidence interval range is wise from 18% to 93%. Thus, the tightness and steepness of the fit in the scatter graph for past against current lost workdays results in a more confidently stronger connection between this past predictor and current outcomes.

However, at the margin, hosts will know more about contractors by using both pieces of information. By itself, past workday rates predict 62% of the variation in current contractor lost workday rates. Adding EMR rates explains an additional 5% of the variation in current outcomes. By itself, EMR rates explain only 13% of the total variation in current contractor lost workday injury rates. So as a general rule, if you had to choose, you should use past lost workday injury rates to explain current rates, but if you did not have to choose, past injury rates and EMR rates together provide more information than either alone.

## Which Is a Better Predictor—Past Safety Outcomes or Current Safety Capacity?

In the data we can divide contractors based on some of their current safety policies and capabilities. A little more than one-third of the contractors have a behavioral-based safety program in place. Slightly more than three-fourths of the contractors have a full-time safety director. Sixty-eight percent have a full-time safety representative on site. Almost 90% of the contractors in our sample have a modified-duty/return-to-work policy while a bit more than three-fourths have a written restricted-duty or light-duty policy. Similarly, somewhat more than three-fourths require that an authorized individual accompany the injured employee to their initial medical treatment. Not all of these factors might be injury prevention capabilities. For instance, a return to

work policy might be thought of not so much as a technique for preventing injuries as a technique for mitigating the costs of injuries. So we might expect that a full time safety director, and/or an on-site full time safety representative and/or a behavioral-based safety program might reduce injuries more than a return to work policy or a restricted work policy or someone assigned to go with you to the doctor when you get hurt.

Alternatively, a return to work policy and/or a light duty policy might reduce the rate of lost workday injuries by reflecting an effort to put injuries into the no-lost-workday column. So these measures may reflect true decreases in injury rates, or they may reflect changes in the way injuries are treated and accounted for.

| | Mean | Standard Deviation |
|---|---|---|
| Does your company have a behavioral based safety program in place? | 37% | 48% |
| Do you have or provide a full time Safety Director? | 78% | 41% |
| Do you have or provide a full time site Safety Representative? | 68% | 47% |
| Does your company have a modified duty/return to work program? | 87% | 34% |
| Does your company have a written restricted duty/light duty policy? | 77% | 42% |
| Does your company require an authorized individual to accompany injured employees to the medical provider for initial treatment? | 78% | 42% |

**Table 5: Measures of the current safety capacity of contractors**

Before we address the question of reduced vs. rearranged injuries, and the question of current capacity vs. past performance, we must first examine whether these

current policies and practices all amount to the same thing. Do all contractors that have a

return-to-work policy also have a light-duty policy? Do all contractors who have a site

Safety Representative also have a company Safety Director? The answer is "almost but

not quite" in both cases. Table 6 shows that 58% of all contractors in our sample have

both a return-to-work and a light-duty policy, and an additional 21% have neither. So

almost 80% have either both or neither. Only 21% have one but not the other. Similarly,

Table 7 shows that almost 80% either have both a site Safety Representative and a

company Safety Director or neither, while 21% have either one or the other but not both.

As we shall see, there is enough variation in our data in the behavior of contractors to

create a regression model testing the efficacy of each policy separately on the prevention

of current lost workday injuries.

| Does your company have a modified duty/return to work program? | Does your company have a written restricted duty/light duty policy? | |
| --- | --- | --- |
| | No | Yes |
| No | 21% | 6% |
| Yes | 15% | 58% |

**Table 6: Cross-tabulation of light duty vs. return to work policies**

| | Do you have or provide a full time site Safety Representative? | |
| --- | --- | --- |
| **Do you have or provide a full time Safety Director?** | **No** | **Yes** |
| No | 26% | 10% |
| Yes | 12% | 53% |

**Table 7: Cross-tabulation of company Safety Director vs. site Safety Representative**

Equation 4 shows a linear regression model predicting current lost workday injury rates based on current contractor practices and policies. In this sample of 526 contractors, 19% of the total variation in current contractor lost workday injury rates is explained by six policy-and-practices variables—three associated with safety programs and personnel, and three associated with injury treatment and return to work. This 19% of total variation in contractor injuries compares with 67% when simply past injury outcome measures are used to explain current injury rates. So, on the face of it, past outcomes appear to be a more powerful class of predictors of the future compared to current safety capabilities. However, this may be true only on this level of safety prequalification measures. At deeper levels of audit such as office and field visits, qualitative measures of safety culture based on direct observation may be more effective than the quantitative yet relative crude measures of safety culture and current capabilities examined here.

**Equation 4: Ordinary lest squares regression model predicting current lost workday injury rate based on current safety policies and practices**

| Source | SS | df | MS | | |
|---|---|---|---|---|---|
| Model | 206.316416 | 6 | 34.3860693 | | |
| Residual | 843.994114 | 519 | 1.6261929 | | |
| Total | 1050.31053 | 525 | 2.00059149 | | |

Number of obs = 526
F( 6, 519) = 21.15
Prob > F = 0.0000
R-squared = 0.1964
Adj R-squared = 0.1871
Root MSE = 1.2752

| log current lost workday rate | Coef. | Std. Err. | t | P>|t| | [95% Conf. Interval] | |
|---|---|---|---|---|---|---|
| has behavior safety program | -.6399875 | .1182739 | -5.41 | 0.000 | -.8723419 | -.4076331 |
| has company safety director | -.7214001 | .1605551 | -4.49 | 0.000 | -1.036818 | -.4059823 |
| has site safety representative | -.4401286 | .1420227 | -3.10 | 0.002 | -.7191386 | -.1611186 |
| has return-to-work program | -.2192005 | .1886576 | -1.16 | 0.246 | -.5898268 | .1514259 |
| has light work policy | -.2552103 | .1530101 | -1.67 | 0.096 | -.5558055 | .0453849 |
| has some accompany you to Dr. | .0847618 | .1426313 | 0.59 | 0.553 | -.1954438 | .3649675 |
| constant | -10.58879 | .1890147 | -56.02 | 0.000 | -10.96012 | -10.21747 |

Once again, in Equation 4, the dependent variable is logged while, in contrast, the independent variables in this model are indicator variables (often called dummy variables) which turn on (=1) when the contractor meets each variables condition. When the independent variable is a zero-one and the dependent variable is logged, the estimated coefficient is a percentage change in the dependent variable based on this condition being in place. So, even though there still is a lot of variation in contractor injury rates that go unexplained in this model, the effect of the contractor having a behavioral based safety program in place (the first independent variable) is very strong. All other things being equal, if a contractor does have a behavioral based safety program, injury rates fall by 64%! And this relationship is both statistically significant and fairly tight with the 95% confidence interval ranging between a 41% drop in injuries to an 87% drop in the lost workday injury rate. If the company has a full time safety director, the effect is even stronger with the point estimate being a fall in the lost workday injury rate of 72%. Add to this an on-site safety representative and the injury rate falls an additional 44%. Taken

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together, these three current safety capability factors can drive injuries down dramatically. Or put the other way, absent these policies and procedures, injuries are substantially higher. But, most contractors do most of these things. Seventy-eight percent have safety directors and 68% have on site safety representatives. So most contractors are wheat and only a minority are chaff when considering these current safety capacity criteria.

But having a preponderance of good contractors is good news in the sense that you can weed out the less safe contractors without reducing the number of qualified bidders substantially. Also, the prevalence of safety directors and representatives may well reflect an evolution in contractor safety management strategies driven probably primarily by past worker compensation costs, but also for this contractor sample, especially, these current safety policies and practices may be driven by the safety prequalification criteria, themselves. After all, this is a sample of contractors from a safety prequalification company's data base. Thus, this is likely a sample of companies that feel strongly the pressure of safety prequalification from the host companies they serve. Very probably, safety prequalification has caused the wide diffusion of these more successful (if more expensive) managerial safety strategies.

This leads us to focus on the one relatively new criterion that is not a majority practice within this sample of contractors. Behavioral-based safety programs are relatively new and in Equation 4, it appears that the adoption of this managerial technique is successful in further reducing injury rates even if all the other practices included in Equation 4 are in place. If prequalification were a practice of picking the best contractor of the lot based on safety criteria alone, Equation 4 would suggest picking contractors

that used a behavior-based-safety-program along with having a company safety-officer and a site-safety-representative. But that would reduce the number of bidders substantially as only 37% of the contractors in our sample use this technique.      The good news for host employers is that because behavioral based safety programs appear to work, they are likely to proliferate. They will proliferate because some safety prequalification programs will use this as one of the standards for prequalification. But behavioral based safety programs will also proliferate because safety prequalification programs that set past outcome standards for injuries and fatalities a criteria are going to pick contractors with better than average past safety outcome rates. The current practice of behavioral safety programs should lead to better past outcomes downstream leading to getting prequalified leading to a further proliferation of this safety management technique. Safety prequalification is a process of picking wheat from chaff but also it is a process of turning more grains into wheat. As contractors come up to speed in adopting better safety management practices, the criteria that encourage those practices will become outmoded simply because everybody will be doing the new best practice. This is a good thing. The contractor community will be safer. But the safety community and the host community will have to continually develop new best practices and they will have to be incorporated in safety prequalification standards. When new criteria such as behavioral based safety programs are initially put into prequalification standards, hosts will face a dilemma of enforcing those standards but losing a substantial number of contractors. This dilemma will diminish as the practice diffuses but eventually it will be replaced by the dilemma that the standard does not distinguish one contractor from another. Thus, there is a quadratic relationship in the effectiveness of current-practice

safety standards. When new, they may work regarding safety selection of contractors but at the cost of eliminating many contractors. When around for a while, they are particularly effective in driving better safety, yet providing for an ample number of contractors. When they are mature standards, everybody follows them and they are not particularly effective in identifying progressive and safer contractors. So in answering the question what current contractor safety practices are key contractor characteristics that should go into safety prequalification standards, we need to realize that this will always be a moving target driven by innovations in safety management and their diffusion across contractors.

We now look back to Equation 4 to notice that the return to work and injury treatment policies do not have statistically significant effects on the current lost workday injury rate—with the exception of having a written light duty policy. This factor is statistically significant at the most relaxed standard level of 10% (meaning in accepting this as a statistically effect, you have a one chance in ten of being wrong). This result suggests that implementing a restricted-light-duty policy lowers lost workday case rates by 25%. But light duty policies and return to work policies are closely intertwined, and if we drop light duty out of the model, the return to work variable becomes statistically significant. The question here is whether these light duty/return to work policies are actually lowering injuries or are simply switching injuries from lost workdays to light duty?

Equation 5 seeks to answer this question by predicting the restricted work injury rate based on whether the contractor has a return to work program, a light duty written policy, and/or someone assigned to accompany the injured worker to the first medical

treatment. Not very much in the total variation in contractor restricted duty injury rates is explained by these variables (just 2%), and two of the three variables are statistically insignificant by themselves. The only variable that lowers the restricted work injury rate is whether or not some accompanies the injured worker to the doctor's office. Because the worker is going to the doctor, an injury has occurred and having someone go with them will not change this fact. All accompaniment can influence is how that injury is recorded. We speculate that going with the worker to the doctor may lead to a shifting of injuries from light duty to no lost time at all. "If you are going with me to the doctor, then I just won't go. Give me a bandage and let's get back to work." The main point is that return-to-work programs do not statistically significantly increase restricted work injury rates.

We conclude from this that return to work programs, as reflected in Equation 5, do have a statistically significant impact in lowering lost workday injury rates. This is probably because return-to-work programs are correlated with other contractor safety management practice that we have not included in our model and do lower lost workday injury rates. Based on that suspicion, we did an omitted variable bias test on Equation 5 and this resulted in the suggestion that additional variables are needed in the model. Recall also that our measures of current safety practices are do-they-have-it-or-don't-they zero-one indicator variables. These do not capture the quality or field-implementation of these programs. More generally we conclude that better and more detailed measures of current safety capacity are needed to both better implement safety prequalification and to better test its effectiveness.

**Equation 5: Ordinary least squares regression model explaining variation in current restricted duty injury rates using contractor has a return to work program,; has a written light duty policy; assigns someone to go to first medical treatment with injured worker**

| Source | SS | df | MS | | Number of obs |
|---|---|---|---|---|---|
| | | | | | F( 3, 423 |
| Model | 21.4321296 | 3 | 7.14404319 | | Prob > F |
| Residual | 676.288492 | 423 | 1.59879076 | | R-squared |
| | | | | | Adj R-square |
| Total | 697.720622 | 426 | 1.63784184 | | Root MSE |

| log of restricted duty injury rate | Coef. | Std. Err. | t | P>|t| | [95% Conf. |
|---|---|---|---|---|---|
| has return to work program | .0112794 | .2590215 | 0.04 | 0.965 | -.4978503 |
| has light duty written policy | -.2662044 | .1860802 | -1.43 | 0.153 | -.6319615 |
| has someone accompany to Dr. | -.4321991 | .1534866 | -2.82 | 0.005 | -.7338906 |
| constant | -11.66273 | .2455534 | -47.50 | 0.000 | -12.14539 |

We are now in a position to answer the question posed at the outset of this

section—which is a better predictor of current lost workday injury rates—current safety

practices or past safety outcomes? In Equation 6, we set up a statistical horserace using

two measures of current practices—does the contractor have a behavioral safety program

and does the contractor have a company Safety Officer?—and also using two measures of

past safety outcomes—past lost workday rates and past EMR's. Equation 6 predicts the

log of current lost workday injury rates. Because the two measures of current safety

capabilities and practices are indicator (dummy) variables, and the two measures of past

safety outcomes are logs of continuous variables, the estimated coefficients for the

current capacity variables are *percentages* while the estimated coefficients for past safety

outcomes are *elasticities* (percentage change in y due to a percentage change in x).

Thus, the coefficients across the two categories of variables (current capacity vs. past

outcomes) are not directly comparable. So we include on the right column of the

Equation 6 table the standardized beta coefficients which allow for the comparison of the relative importance of each variable.

Past safety performance wins this horserace by a mile. First, only one of the two current safety capacity horses finishes the race (i.e. is statistically significant). Second, the beta coefficient for having a safety director is on a par with the beta coefficient for past EMR rates, but past lost workday injury rates are much more important than any of the other three variables in the model. The simple conclusion is that past performance— the momentum factor—is strongly predictive of current safety outcomes and more predictive than current safety capacity

**Equation 6: Ordinary least squares regression model predicting the log of current lost workday injury rates with two measures of current capacity--behavioral safety program and company safety officer, and two measures of past safety outcomes, past two years average**

| Source | SS | df | MS | | |
|---|---|---|---|---|---|
| Model | 463.178485 | 4 | 115.794621 | Number of obs = | 370 |
| Residual | 219.527118 | 365 | .60144416 | F( 4, 365) = | 192.53 |
| | | | | Prob > F = | 0.0000 |
| | | | | R-squared = | 0.6784 |
| | | | | Adj R-squared = | 0.6749 |
| Total | 682.705603 | 369 | 1.85015069 | Root MSE = | .77553 |

| log of current lost workday rate | Coef. | Std. Err. | t | P>|t| | Beta |
|---|---|---|---|---|---|
| has behavioral safety program | -.0518252 | .0876107 | -0.59 | 0.555 | -.0185034 |
| has company safety director | -.2288998 | .107577 | -2.13 | 0.034 | -.0667117 |
| log of past workday injury rate | .8344926 | .0373003 | 22.37 | 0.000 | .7594815 |
| log of past EMR's | .5353095 | .1923298 | 2.78 | 0.006 | .0883784 |
| constant | -1.446673 | .4334699 | -3.34 | 0.001 | . |

But this conclusion would be too simple for two reasons. First, past outcomes may be predictive of current outcomes but you cannot know why. . The finding is very much in line with the literature demonstrating that OII performance is reflective of features of process safety management that will affect OII (Rosenthal, Kleindorfer and Elliott 2006), but direct evidence on PSM is absent. The fact that a contractor's safety results yesterday will predict his safety results today is useful but is limited by the fact that, by itself, this information does not tell you *why* the contractor has been safe—is it skill? Is it luck? Combination of both? This would be okay if all the host wished to do was limited to lost workday injuries. But the host is interested in limiting fatalities, catastrophic events, and property damage. As noted above, the process and metrics required to reduce LP-HC/catastrophic events may not be the same as for OII. All of these may be correlated with lost workday injuries, but if the correlation is not precise, then trying to contain these events using only past lost workday outcomes as a predictor will be imprecise even though it is very precise in predicting itself.

Second, past outcomes may be the result of past implementation of behavioral safety programs, the hiring of a full time safety director, the assignment of site safety representatives, and a whole host of other past safety activities reflected in current measures of safety capacity. But these will get lost in Equation 6. They will all get buried in the past injury-outcome measure. So the horserace is not quite fair. Current safety capacity gets hidden in past safe outcomes and the past safe outcomes get credit for what the past and present safety capacity is accomplishing. Therefore, if the host wishes to manage with safety prequalification criteria not only gross measures of safety outcomes, but also detailed refinements in those safety outcomes, the host needs both

horses in the race, both measures of past results and measures of current capacity. As one host safety director told us "[The] best indicators of good performance [are] history on host site, strong local leader[ship] and percent turnover [of the contractor and the labor force]." That is—past performance, current safety capability and underlying economic conditions (wages, worker age, contractor turnover, labor turnover, etc.) are the primary factors that key contractor indicators that should be in a safety prequalification standard. In fact, several of these factors, as well as training and perception of supervision by host management, were aspects of contracted work significantly associated with injuries within the petrochemical industry cited in Chatper 1 (Rebitzer, 1998).

## Summary

We asked hosts to indicate what criteria regarding contractor characteristics they ask for in their safety prequalification procedures. A typical response was: "Total Recordable Incident Rate, Lost Workday Incident Rate, Worker Compensation Costs, Experience Modification Rate, Availability of Safety and Health Programs." In our analysis of the survey of host safety professionals, we summarized the collective wisdom regarding what contractor characteristics are key to effective safety prequalification. In our interviews with health and safety executives, we heard repeatedly that a main issue is weighing the relative importance of past performance versus current contractor safety capabilities. In this chapter, we have statistically measured the relative efficacy of competing measures of contractor past safety performance and current safety capacities on current lost workday injury rates. We used samples of contractors drawn from the safety prequalification service company to test which characteristics were predictive and

whether the application of prequalification standards, themselves, had an independent effect on safety outcomes.

We realized in this chapter that safety prequalification and indeed safety management, itself, is a dynamic process. We found, for instance, that past injury outcomes were highly predictive of current injuries with an elasticity of around .90 depending on the statistical model. This means that in choosing between two contractors, one of which had double the past injury rate compared to the other, you could expect that the more dangerous contractor will have almost-but-not-quite double the injuries on your work site today. Why almost-but-not-quite? Why .90 and not 1.00? The reason is contractors learn from their past mistakes. There are bad habits that persist, but there are bad habits that are reformed. So the momentum from the past is about 90% not 100%. Furthermore, if the past lesson is pretty severe—the injury was severe or the event led to fatalities—the learning is greater. This makes predicting the present from the past tricky because contractors learn from the past and change. This is a good thing. Host employers want the community of contractors to improve their safety management. So host safety professionals want also to focus on current contractor safety capabilities.

In our data, we had several measures of contractor safety capabilities— behavioral-based safety programs, company safety directors, on-site safety representatives—as well as several measures of injury treatment—return to work programs, light duty policies, worker accompaniment to medical treatment. These were crude measures in the sense that we only knew whether the contractor had these policies and programs but not how well they were implemented. Nonetheless, we found strong statistically significant improvement in current contractor safety outcomes if they did

have any or all of our three measures of current safety capabilities. We did not find that injury treatment programs were strongly associated with improved safety. In some sense, this is good news because the most likely impact of return-to-work programs or light duty policies or accompaniment to doctor policies is not to reduce overall injuries but to shift those injuries from one category to another. We did not find strong statistical evidence that this was occurring among our sample of contractors. This means, from a prequalification perspective that measures of past safety outcomes are not being strongly altered by injury treatment policies. The numbers can, for the most part, be believed. Thus, current safety programs are important contractor safety prequalification characteristics.

But how should hosts weigh the relative importance of past outcomes to current capabilities. Based on the measures of current capabilities that we have, past safety outcomes are stronger predictors of current safety outcomes compared to current safety capabilities predicting current outcomes. Habit trumps process. However, this result may be because we only drilled down to the second level of the four-level safety prequalification process. We did not utilize data from the office-field audit nor the worksite field audit. This is fair given current safety prequalification practices that often do not go past paper audits to face-to-face audits. But it may well be that face-to-face audits, although more expensive, nonetheless generate better information about how the rubber hits the road when implementing the current safety programs we have measured. We know these programs are effective but when racing the measure of these programs against past safety outcomes, these current safety programs lose their explanatory power. This power in explaining current safety outcomes may regained if we had more subtle

and careful measures of which contractors had good behavioral safety programs, which contractors had safety directors with staffs, which contractors had site safety representatives which were well trained and other measures of the effectiveness of these programs. We also were primarily measuring OII outcomes, and not the rarer RMP recordables. The importance of current safety programs, and information garnered through field audits may be of greater import when considering risk of LP-HC events. In the data we analyzed, we had only the presence or absence of these programs. If that is all the information that the host employer has before him in safety prequalifying contractors, the host should weigh past performance higher than current safety capabilities. But in our next chapter, we will discuss what the host should have before him when we describe a model safety prequalification program.

# Chapter 4 A Model of Contractor Safety Prequalification

.        In this chapter we develop a model of contractor safety prequalification that calibrates individual contractor capabilities against varying levels of risks associated with different projects.  This model also will identify in general terms the types of projects that are best suited for prequalification safety standards.  Our model may be thought of both in terms of a decision tree and in terms of specific tradeoffs.  The basic decision tree is presented in Figure 3.  In the text, we present this model through the perspective of specific tradeoffs the host employer faces—the tradeoff between safety prequalifying contractors vs. having more contactors bidding on the work; the tradeoff between inexpensive contractor prequalification measures with perhaps limited ability in identifying true contractor safety capabilities vs. more time-and-money costly prequalification criteria that may more fully capture contractor safety attributes; the tradeoff between pass-fail prequalification standards vs. point systems that weigh contractor safety against contractor price; the tradeoff between single host employer vs. multiemployer contractor safety prequalification systems; and the tradeoff between contractor safety prequalification vs. contractor-worker safety prequalification.  The sweet spot in all these tradeoffs will depend upon the nature of the safety risks and the economic aspects of the work being brought to market by the host, as well as host location, host safety culture, host proprietorial concerns regarding its approach to safety management, the availability and suitability of third party safety prequalification services and other factors discussed below.

# General Decision Tree for Safety Prequalification
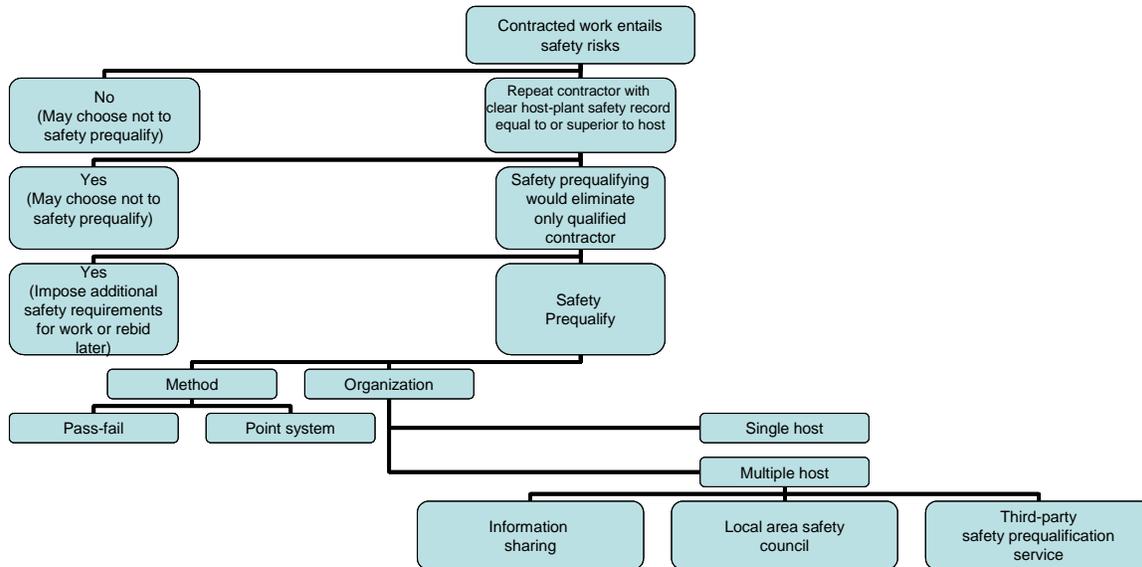


**Figure 3: Basic decision tree for safety prequalifying contractors on host sites**

In trading off the costs of contractor safety prequalification against prequalification benefits, we are searching for a balance between the safety risks and economic pressures on the host employer. Here we will present a brief discussion of how our approach fits into the broader literature on the costs and benefits of safety prevention.

Finally, in contractor safety prequalification, one size does not fit all—and hosts may take different approaches based not only on the work at hand, but also the timing of the work, and the plant in which the work is located. So here we do not recommend one approach, but rather we identify the major tradeoffs that the host employer faces in determining what approach to take.

### Formal Cost-Benefit and Cost-Effectiveness Analyses in Assessing Tradeoffs in Safety Prequalification: Strengths and Limitations

Economy-wide estimates of the annual costs of occupational injuries and illnesses in the United State range nearly an order of magnitude, from $155 billion to over $900 billion (all in $1992), depending on whether a traditional "human capital" or a "willingness-to-pay" methodology was undertaken.[19] These annual cost estimates can be divided into costs to society and costs to the individual. The "human capital" approach generating the lower figure of $155 billion above, demonstrates the vast magnitude of the annual economic burden to society of work-based injuries and illnesses: $132.8 billion of the total $155 billion or 86% is associated with injuries and fatalities and is composed of an estimated $38.4 billion in medical and other direct costs, and a remaining $94.3 billion lost productivity.

Occupational safety initiatives, whether undertaken by public or private entities, are directed at reducing the societal burden of workplace accidents and exposures. Of course, any such initiatives entail a cost in-and-of-themselves; so a comparison of expected reduction in burden (benefit) to the expected cost of intervening, provides the rough framework for a benefit-to-cost analysis (say) OSHA regulations or company safety programs or contractor safety prequalification procedures.

If there are several safety options under consideration to be assessed against each other, the comparison between them takes the form of cost per some unit of burden

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[19] In simple terms, the human capital approach looks at the loss to productivity associated with an injury or death while the willingness-to-pay approach looks at what people are willing to pay in order to reduce the risk of an injury or death. Leigh JP, Markowitz S, Fahs M, and Landrigan. 2000. Costs of Occupational Injuries and Illnesses. (Ann Arbor: University of Michigan Press).

reduced, or a "cost-effectiveness" analysis. So, for instance, asking the question should host employers superficially or in great detail examine the safety qualification of contractors, from a safety engineering point of view, the answer might always be examine the contractor in great detail. But from an economic point of view the answer might be, if there are only a few potential contractors to examine and the risk exposure is high, examine each in great detail. If, on the other hand, the risk exposure is low and there are lots of potential contractors to examine, then perhaps the host company should either more casually inspect the safety credentials of each contractor due to cost, and more closely monitor the eventually-hired contractor. From an economics point of view weighing alternative approaches to safety prequalification boils down to a question of the cost effectiveness of the alternative approaches. Cost effectiveness, from a host employer's perspective, is not the narrower question of how does a safety program affect production costs. It is the broader question of comparing the cost of each possible approach against the reduced safety burden (or risk) of each approach.

Incentives are critical to the degree to which interventions will be undertaken by individual firms (both host employers and contractors). Simply because expected societal benefits outweigh expected societal costs from the integration of a specific model of safety prequalification, for example, is not sufficient for individual firms to undertake such pre-qualification practices on their own initiative. If a substantial amount of the expected cost reduction (benefit) will be reaped outside the firm, while the expected costs are borne primarily or solely by the firm, such "externalities" or "spillover effects" provide a disincentive to undertake such practices, even if they are best practices from a societal vantage point or a safety engineering or safety management standpoint. Cost

evaluation therefore needs to be assessed at the level of the individual actors involved, as well as at the societal level, so as to gain a fuller understand the nature of incentives, and how incentives might effectively be addressed. None of this is to deny the fact that some host employers have simply adopted a philosophical commitment to safety and will pursue safety initiatives almost without regard to costs. But, here, in this chapter, we assume the more general case where the host employer is inclined to make a broadly inclusive but nonetheless fundamentally economic analysis comparing alternative safety approaches to managing contractors.

"Expected" costs and "expected" benefits are used above in presenting cost evaluation methods because uncertainty and risk are inherent in assessing the results of any type of safety intervention, as well as, the extent of burden carried by the firm. Such probabilities can be integrated into formal cost-benefit and cost-effectiveness analyses, as can the cost to reputation of a low probability but high-visibility/high-consequence event. Reputation is an asset of the firm that may depreciate significantly by a safety breach, and the neglect or mis-assessment of such intangible assets will also distort a formal cost evaluation. Larger or branded firms engaged in certain types of activities with high public visibility, may face greater reputational costs in a given type of incident compared to smaller or non-branded firms. Thus, in some cases, the cost of an accident is necessarily greater to the host employer than it is to the contractor. Furthermore, because an asset such as company reputation is so often difficult to formally assess, and because some of the probabilities associated with such events are fraught with uncertainty, "corporate culture" takes on very strong prominence with respect to health and safety performance in the literature and in our survey results. The emphasis of corporate

culture acts as an informal proxy for the inherent difficulties in performing refined and/or reliable formal cost-benefit and cost-benefit analysis. So, because the economics become fuzzy, "do the profitable thing" morphs into "do the right thing."

The model for contractor safety prequalification summarizes, to some extent, current practice, and such practice reflects the current context of liability, regulation, industrial structure, and industrial relations under specific and changing conditions of contracting and sub-contracting. Formal methods of cost-benefit and cost-effectiveness analysis can formally integrate aspects of such context to better understand not only the type of pre-qualification that is conducted under current practice, but how to facilitate the transition to a model of best practice. Put simply, contractor safety prequalification is a matter of safety and economics but the economics is formed in a context of law, industrial structure and industrial relations.

Formal tools of cost assessment and evaluation in health, health care, and in workplace health and safety, have grown more sophisticated over the past several decades, and have been increasingly solicited and relied upon by public agencies and private firms. Such formal assessment may be of value for informing decisions, but oftentimes cannot be dispositive. Such is the case because refinement in method has often outrun the quality of available data, and the discrepancies between the assumptions that these formal tools require, and the real world context, often further limits their practical value in decision-making. Also, it is of no particular value for an individual firm to have economy-wide estimates of the cost of injury, even of particular types of injuries if the firm-level intervention is to be undertaken in a context that departs significantly from the economy-as-a-whole in a manner that was not addressed in the

formal economy-wide cost-benefit estimate. Estimates also can vary widely, depending

on the method of assessment adopted. Therefore, in what follows we will not present a

formal cost-benefit analysis, but rather we will broadly outline the cost-benefit

assessment through an analysis of the economic and safety tradeoffs the host employer

confronts. Ultimately, each host must place these general considerations within the

context of their company's economic and safety-risk circumstances.

## *The Tradeoff between Safety Prequalification and More Bidders*

Should hosts safety prequalify contractors? Part of the answer to this questions is

based on whether or not the number of contractors bidding on the work is significantly

reduced by imposing safety prequalifying standards. However, restrictions on the

number of bidders may be offset in many cases by maintaining lists of safety prequalified

contractors or using local area safety councils or third-party safety prequalification

service providers. Figure 4 shows a general decision tree for using bid lists or third

parties to maintain sufficient contractor competition when imposing contractor safety

criteria. The key issue is whether or not contracted work accounts for a high percentage

of the host's overall site work. If it does not, then even if safety prequalification criteria

tend to limit the number of qualified bidders, the economic effects of this limitation on

the host's overall costs will be relatively small. On the other hand, if contracted work is a

substantial portion of the hosts overall costs, limitation on the number of bidders can be

costly. Under these circumstances, it matters whether or not, this substantial portion of

the host's costs is done by a limited number of large contractors who remain on site for

long stretches of time. Under these circumstances, the host may economically maintain

shorter safety prequalified bid lists or may safety prequalify case-by-case on the

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relatively infrequent occasions that the current contract has expired. Also, it should be noted that in general, when the value of the project to be let is large, the number of bidders required to get a competitive price need not be many because the opportunity cost of losing the bid is sufficiently high as to get these limited number of bidders to take the bid seriously and submit a competitive price.

### Safety prequalified bid lists to offset restrictions on the number of bidders
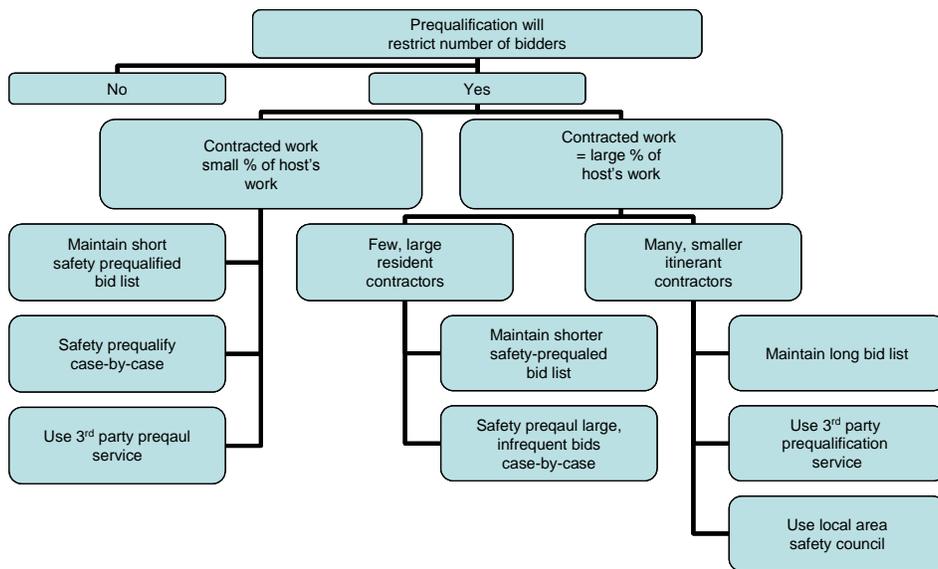


**Figure 4: Decision tree for using bid lists or prequalification service providers to counter limits to the number of bidders caused by contractor safety criteria**

On the other hand, when bid openings for new contracted work are frequent and the size of the jobs to be let are small, the host needs a sufficient number of bidders in order to get a competitive price. Here maintaining longer safety prequalified bid lists or using a third-party service provider or local area safety council to provide the host with a longer list of safety-qualified contractors is needed in order to contain the costs of

imposing safety criteria on contractors.   Below we work out the logic and empirics of these conclusions.

**When bid lists are longer or shorter.**  Among host-employer survey-respondents in our large-employer survey, 77% of their contracted work is safety prequalified.  Of the work that is prequalified, 15% of the contractors fail to become prequalified.  When asked to rank various reasons why a host employer might not safety prequalify contractors, the main reason given (14 of 20 responses) was that some work poses little or no safety risks.  However, in considering work that does pose safety concerns, in half the cases (10 out of 20) respondents indicated that they might not safety prequalify contractors if it restricted the number of available bidders.  Bidding competitiveness or the lack thereof is at the heart of the potential tradeoff between safety prequalification and the economics of procurement.

Figure 5 shows the percent distribution of the number of safety prequalified bidders on each company's bid list.  Recall that survey respondents here are executives at major American international corporations and consequently, many of the company-wide bid lists are long.
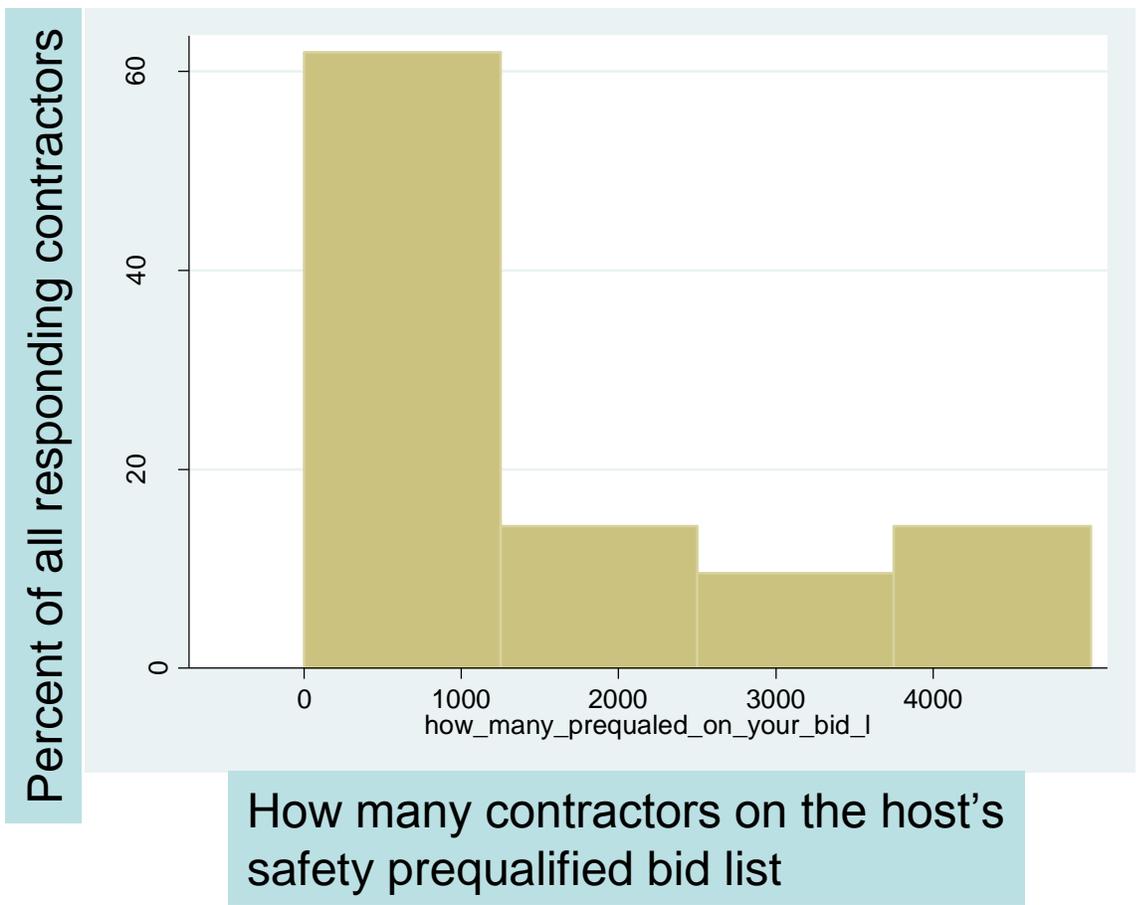
**Figure 5: Percent distribution of the number of prequalified contractors on host bid lists**

Sixty percent of the hosts in this survey had from zero to about one thousand safety

prequalified contractors on their bid lists with the remaining 40% having above one-

thousand contractors on their bid lists. On its face, this would seem to be an ample

number of prequalified bidders, but in fact, the number of usable bidders for any one

project is considerably smaller because these bid lists are for multiple work sites spread

across an international landscape, and these contractors span a wide range of specialties.

Nonetheless, the contractor community serving these hosts is clearly large.
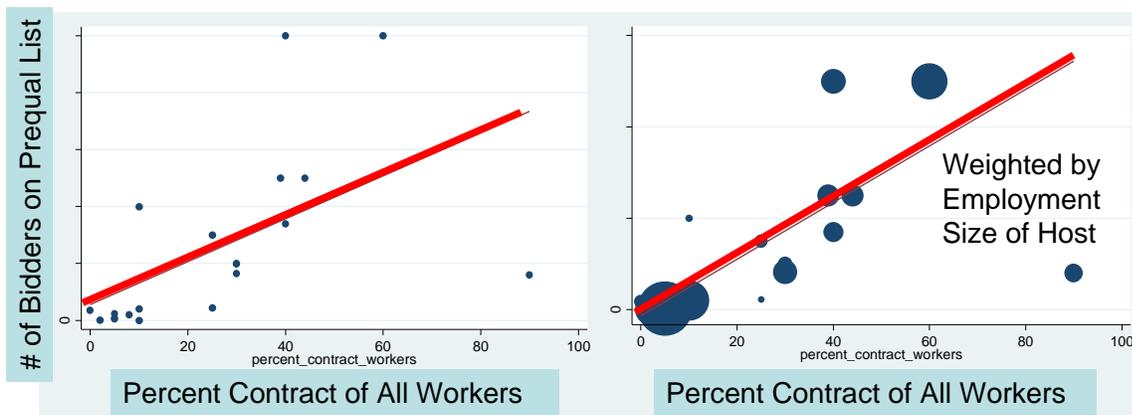


**Figure 6: The number of contractors on host bid lists rises as the percent of all work done at host sites by contractors rises.**

Figure 6 shows that as the percent of the entire host's work that is done by contractors rises, the number of contractors on the host's bid list also rises. So the more the host uses contractors, the longer is the safety prequalified bid list the host maintains. On the left hand panel in

Figure 6, the regression line is unweighted while on the right-hand panel the regression

line is weighted by the employment-size of the host. This weighting is represented on the

right by larger dots for larger host companies. The positive relationship between the

percent of all work done by contractors and the number of contractors on the host's bid

list is not substantially changed based on differences in size among these very large

companies in the sample. This means that at least among large contractors size is not

what determines the length of the bid list as much as simple dependency-on-contractors in determining how long a bid list the host will maintain. If contractors are the meat and potatoes of your work site, you will maintain a long list of safety prequalified contractors to insure that the bids you receive are competitive. The cost of doing so is worth it.

Now let us look at this a little more carefully through multiple regression analysis. Equation 7 provides an ordinary least squares linear regression model explaining the number of bidders that will be on the host employer's bid list based on the percent of all the work done by contractors on the host's sites, and the average employment size of the contractors serving the host. All variables in Equation 7 are in logarithms so the estimated coefficients for the explanatory variables are elasticities (i.e. a percent change in y due to a percent change in x). The results indicate that if you double the percent of all work done by contractors on the host's sites (say go from 10% to 20% or 20% to 40%), the bid list for the host will increase by about 126%. On the other hand, if you double the size of the contractors serving the host, the length of the bid list falls by about 46%. So hosts maintain longer bid lists to the extent they heavily rely upon contractors, but those bid lists are shorter to the extent that the contractors are large. This second result may be due to the possibility that when contractors are larger, there are fewer of their type within the contractor community to put on bid lists. And it may also be that when contractors are larger, they remain on the host's site longer requiring fewer backup contractors on the bid list. A "nested" contractor—one that is resident on the host's site—is likely to be an example of both these possibilities. So bid-list-length is sensitive to both the importance of contractors to the host's operations and the size of the contractors the host uses.

**Equation 7: Ordinary least squares regression model predicting the number of contractors on the host's bid list based on the percent of all the host's work done by contractors and the size of the contractors (all variables logged, estimated coefficients are elastic**

| Source | SS | df | MS | | | | |
|--------|-----|-----|-----|-----|-----|-----|-----|
| Model | 56.6107223 | 2 | 28.3053611 | | Number of obs = | | 18 |
| Residual | 7.87773761 | 15 | .525182507 | | F( 2, 15) = | | 53.90 |
| | | | | | Prob > F = | | 0.0000 |
| | | | | | R-squared = | | 0.8778 |
| | | | | | Adj R-squared = | | 0.8616 |
| Total | 64.4884599 | 17 | 3.79343882 | | Root MSE = | | .72469 |

| Log of # of bidders | Coef. | Std. Err. | t | P>\|t\| | [95% Conf. Interval] | |
|---------------------|-------|-----------|-----|--------|---------|---------|
| Log of Contractors % of All Work | 1.262527 | .1877871 | 6.72 | 0.000 | .8622678 | 1.662785 |
| Log of Size of Contractor | -.4278048 | .1076621 | -3.97 | 0.001 | -.6572812 | -.1983283 |
| Constant | 3.48902 | .7170634 | 4.87 | 0.000 | 1.960636 | 5.017405 |

percentage-point increase in the host's work that is done by contractors, the host is 1.17 times more likely to say that at least some of that work should not be safety prequalified because prequalification reduces the number of available bidders.

In contrast, controlling for the amount of work contractors do, the longer the host's bid list, the less likely the host will say do not safety prequalify because it limits the number of bidders. The odds ratio indicates that with each additional 100 bidders on the company's overall bid list, the host is only 84% as likely to say "do not safety prequalify at least some work because it limits the number of bidders." Thus, safety prequalification requires more exceptions or exemptions to the extent that the host relies upon contractors more, and safety prequalification is easier when there are lots of bidders that have prequalified. Thus, hosts that rely upon contractors to do a lot of their work need to put in place systems that will create and maintain a longer list of safety prequalified contractors. Multiemployer safety prequalification programs are one way of doing this. At the same time, hosts who rely upon contractors more need to have formal

methods for exempting work from safety prequalification based on the economic costs associated with limiting bidding pressure.

The lower panel in Equation 8 adds two additional variables to the model—the percent of all contracted work done by contractors who are on the host site for less than six months, and an indicator variable identifying those hosts whose contracted work is primarily in the use of construction contractors. Looking at the new variables first—for every percentage-point increase in the amount of contracted work done by short-term contractors (less than 6 months), the host is 1.04 times more likely to say "do not safety prequalify at least some of our work because it limits the number of bidders." Putting this result in larger units, for every 10 percentage-point increase in the amount of contracted work done by short-term contractors, the host is 1.4 times more likely to say "do not safety prequalify because it limits the number of bidders." Furthermore and dramatically, if the host is primarily using construction contractors (as apposed to maintenance or service contractors), the host is 15 times more likely to say "do not safety prequalify because it limits the number of bidders." So short-term contractors and construction contractors create economic pressures on the safety prequalification system more than long term contractors or maintenance/service contractors. Why?

We believe the construction outcome in the bottom panel of Equation 8 reflects two inter-related factors. First, construction contractors are much more likely to use extended layers of subcontractors compared to maintenance and service contractors. Second, the formation of construction contracts, and particularly the formation of construction subcontracts, is fast relative to the ramping up to a maintenance or service contract. Taken together, fast ramp-up and articulated subcontracting make safety

prequalification through the deep layers of subcontractors difficult and costly. Therefore, safety prequalification more easily limits the number of construction contractors compared to prequalification procedures for maintenance and service contractors.

The result that the use of short-term contactors puts greater economic/competitive-bid restraints on safety prequalification programs is again due to two interrelated factors: first, when contractors are on the job a short period of time, then the costs of contractor safety prequalification can only be spread across that short period. Second, sometimes short work is smaller work, so at least in some cases, the cost of safety prequalification can only be spread across a small value of work. If both these factors hold, then safety prequalification is going to discourage contractors from bidding on the work because the cost of safety prequalification will dig too deeply into the contractors' profits. Two possible solutions to these factors are 1) use some form of multi-host-employer contractor safety prequalification program so that short term contractors can prequalify for multiple work in one prequalification process, thus spreading the costs of prequalification more widely, and/or 2) host employers can directly assume some of the costs of safety prequalification for short term work.

The initial factors in the Equation 8 model—percent contractors' share of all the host's work, and the number of contractors on the bid list, are each slightly stronger in their effect in the expanded model in the lower panel. However, while the overall explanatory power of the model rises with the addition of these two new variables (i.e., the pseudo-R-Square rises from .30 to .56), the individual statistical significance of each variable is marginal due to the colinearity of these four factors. For instance, construction contractors, as a group, are likely also to be short-term contractors. So these

two variables will be collinear reducing our ability to sort out the individual statistical significance of each one separately. Nonetheless, we believe that these are suggestive results in the lower panel of Equation 8 indicating that safety prequalification is more difficult when contractors are on the job a shorter period of time or when contractors are construction contractors (with all the subcontracting that typically entails).

**Equation 8: Logistic regression models predicting a host rejecting safety prequalification because it would limit the number of contractors bidding on the work**

```
Logistic regression                          Number of obs   =          20
                                              LR chi2(2)      =        8.34
                                              Prob > chi2     =      0.0155
Log likelihood = -9.5940072                   Pseudo R2       =      0.3029
```

| Reduces # bidders | Odds Ratio | Std. Err. | z | P>\|z\| | [95% Conf. Interval] | |
|---|---|---|---|---|---|---|
| % contractors of all work | 1.17263 | .0917467 | 2.04 | 0.042 | 1.005919 | 1.366971 |
| # bidders on list (100s) | .8410063 | .0820585 | -1.77 | 0.076 | .6946179 | 1.018246 |

```
Logistic regression                          Number of obs   =          19
                                              LR chi2(4)      =       14.79
                                              Prob > chi2     =      0.0052
Log likelihood = -5.7509114                   Pseudo R2       =      0.5625
```

| Reduces # bidders | Odds Ratio | Std. Err. | z | P>\|z\| | [95% Conf. Interval] | |
|---|---|---|---|---|---|---|
| % contractors of all work | 1.344131 | .2511854 | 1.58 | 0.114 | .9319077 | 1.9387 |
| # bidders on list (100s) | .7176977 | .1701743 | -1.40 | 0.162 | .4509329 | 1.142276 |
| % contractors < 6 months | 1.036606 | .0254097 | 1.47 | 0.142 | .9879814 | 1.087624 |
| % construction contractors | 15.50151 | 32.55249 | 1.31 | 0.192 | .2528646 | 950.2984 |

Circumstances where Safety Prequalifying More or Less Likely to
Restrict the Number of Bidders
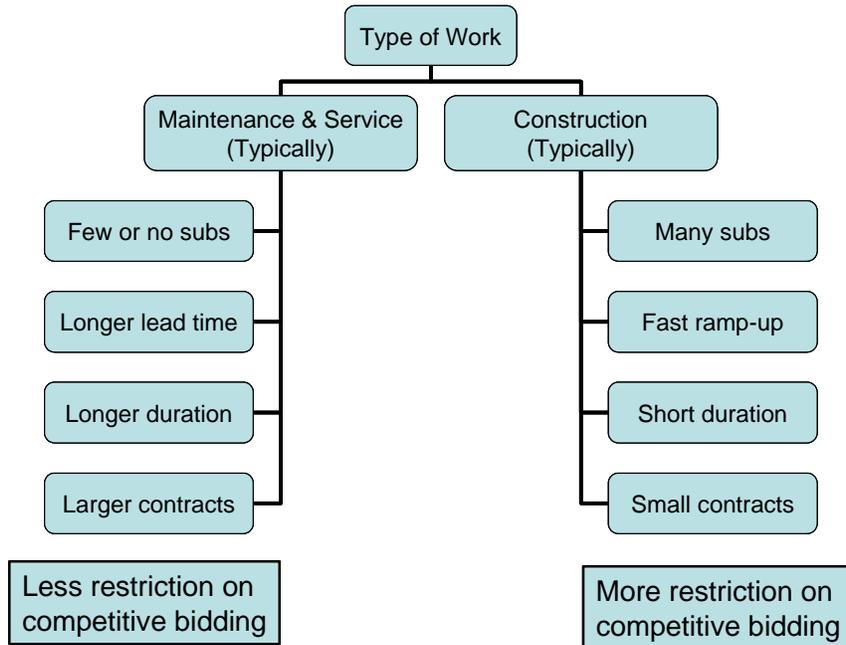


**Figure 7: The effects of the type of work on competitive bidding under contractor safety
prequalification**

Figure 7 summarizes the forgoing with a decision tree.  Contracted work that

entails few or no subcontractors, has a long lead time before bidding in which to gather

potential bidders, work of longer duration and of a larger size will impose less restrictions

on competitive bidding.  This type of work is more often maintenance and service work

on the host's site.  Work involving many subcontractors, that has a fast ramp-up to the

bid, that is of short duration and has a smaller economic value will experience greater

problems with obtaining competitive bids under safety prequalification criteria.  This type

of work is more often construction work.  This decision tree does not map out the entire

decision matrix regarding whether the host should safety prequalify because Figure 7 only identifies the costs, and not the benefits, from contractor safety prequalification. Where the benefits are small and the costs are large, hosts have, as indicated in the empirical analysis above, often chosen not to safety prequalify at all. However, as indicated below, this need not be the conclusion because there are techniques to reduce the cost of safety prequalification caused by the nature of work.

All other things being equal, safety prequalification or any other type of contractor prequalification reduces competitive pressure on bidders by limiting bids to prequalified bidders. Prequalification lists also may inform bidders of who their competitors are allowing for strategic bidding behavior on the part of contractors. These factors argue against short, long-standing prequalification lists. Contractors should be subject to prequalification renewals not only to check on their evolving safety practices, but also to put a check on collusive behavior. On the other hand, the process of prequalification has a cost to the host-employers and the contractors. Established lists of prequalified contractors may, by providing economies of scale in prequalification, increase the number of contractors available for any one project by lowering the cost of safety prequalification. Thus, owners must balance the problems associated with facilitating strategic bidding with the benefits associated with economies of scale in prequalification. The results from Equation 8 indicate that bid lists should be longer to make safety prequalification more feasible, but bid lists should be renewed to provide an ongoing monitoring of both contractor safety and bidding practices.

The results from Equation 8 also indicate that longer projects are easier to safety prequalify without confronting bidder limitations. There are two reasons for this. First,

the costs of prequalification to both the contractor and the host are lower to the extent that they can be spread across a longer project. Second, because longer projects tend to be bigger and more valuable project, the host does not need as many contractors bidding on the project to get a competitive bid. The opportunity cost of losing longer/bigger projects is higher to the contractor, and consequently each contractor will spend more time estimating the cost of the work, and contractors will be more willing to pare their profits in order to get the work. Thus, safety prequalification of longer, larger projects is not only more important from a safety standpoint, it is also more feasible from an economic standpoint. Our data limitations do not allow us to identify a precise "sweet spot" in this tradeoff between safety prequalification, on the one hand, and small, short and/or construction-oriented projects on the other. But any model safety prequalification program must be scaleable with no one-size-fits-all procedures. Where bid lists are short, contractor presence is short, and/or contractor subcontracting is extensive, then safety prequalification standards and practices need to adjust. One way out of many of the aforementioned tradeoffs is to use a multiemployer safety prequalification program either through informal cooperation among hosts or area safety councils or third-party contractor safety prequalification service companies. In each case, by spreading the cost of safety prequalification across multiple hosts, bid lists can be longer. The tradeoff here is in proprietorial advantages hosts may have using their own safety prequalification program. The tradeoff between proprietorial and multiemployer contractor prequalification approaches will be discussed below.

In creating a scalable model of safety prequalification, the underlying tradeoff is between the safety costs of an unsafe contractor and the economic costs of safety

prequalification. The safety costs are primarily derived from two factors—whether the contracted work will be close to the center of, or towards the periphery of, safety risks on the host's work site; and how safety capable the contractor is. The economic costs are primarily derived from three factors—whether safety prequalification limits contractor competition, whether there are multiple layers of subcontractors making prequalification logistically difficult, and whether the job is so short term as to make safety prequalification a substantial fixed cost.

## The Tradeoff between Safety Benefits and Prequalification Costs—Modified by Various Degrees of Inherent Safety Dangers

High risk contractors come in two flavors: contractors who work unsafely and contractors who do dangerous work. The safety risks of a particular contractor is the product of these two factors. Dangerous work may include:

- Construction, renovation, demolition

- Large equipment installation and repair

- Boiler service

- High voltage electrical work (energized electrical work over 600 volts)

- Contractors whose activities involves, but is not limited to:

  - permit required confined space entry,

  - hot work/welding,

  - working at elevated locations,

  - working with compressed gases,

  - diving,

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- Lock Out/Tag Out,

- use of cranes and heavy equipment

- work in excavations and trenches (as defined by prevailing local

   regulation or internal requirements)

- hazardous materials

Safety prequalification always involves trying to separate the safe from the unsafe

contractor, but the issues become more important and the distinction more critical when

the work is inherently more dangerous. In balancing the benefits of enhanced safety

against the costs of prequalification, host employers have the option of performing a

safety risk assessment of the work they are going to contract out. Some hosts never do

this. Most hosts do this at least some of the time, and many hosts do this almost always

or all of the time. In our ORC survey, for instance, 16% of respondents safety risk

assessed "infrequently or never," 40% safety risk assessed "sometimes" and 44% safety

risk assess "usually". Similar results were obtained from our RMCOEH survey.[20]

**Equation 9: Ordinal logistic regression predicting how often hosts safety-risk assess work to be contracted out based on the size of the host, whether the host uses a prequalification service, if the host is concerned prequalification will limit the number of bid**

```
     Ordered logistic regression              Number of obs   =        24
                                               LR chi2(6)      =     17.63
                                               Prob > chi2     =    0.0072
     Log likelihood = -15.860912               Pseudo R2       =    0.3572
```

| Risk assess work to be done | Odds Ratio | Std. Err. | z | P>\|z\| | [95% Conf. Interval] | |
|---|---|---|---|---|---|---|
| # of host employees (1000s) | 1.052757 | .0241072 | 2.25 | 0.025 | 1.006552 | 1.101083 |
| host uses prequal service | 12.52555 | 15.84797 | 2.00 | 0.046 | 1.04909 | 149.5481 |
| concerned prequal limits bids | 10.64624 | 12.78395 | 1.97 | 0.049 | 1.011759 | 112.025 |
| % work contracted out | 1.061672 | .0352556 | 1.80 | 0.072 | .9947732 | 1.13307 |
| contract wages = host wages | 7.565906 | 8.978339 | 1.71 | 0.088 | .7391859 | 77.4405 |
| # of contract workers(1000s) | .9379084 | .0389199 | -1.54 | 0.122 | .8646464 | 1.017378 |
| /cut1 | 2.865015 | 1.532939 | | | -.1394894 | 5.86952 |
| /cut2 | 6.503466 | 2.21745 | | | 2.157344 | 10.84959 |

---

[20] "Infrequently or never," 15%, "sometimes," 22%, "usually," 49% and "we do not have a safety prequalification program," 14%.

Equation 9 provides a model to help us understand when hosts perform safety risk assessments of the work to be contracted out, and when they do not. The ordered categories in the dependent variable are 1=never risk assess, 2=sometimes risk assess, 3= always or almost always safety risk assess work that is to be contracted out. The first independent variable, the number of host employees indicates that for every additional 1000 host employees, the host is 1.05 times more likely to engage in safety risk assessment of the work to be contracted out. This probably reflects economies of scale in safety prequalification procedures with larger host companies having well established safety departments and programs leading to a more uniform approach to safety risk assessment.

If the host uses a safety prequalification service provider or the host shares information about the safety history of contractors with other hosts, then the host is 12 times more likely to risk assess the contracted work. This probably reflects more advanced safety practices among some hosts compared to others. It also may be that prequalification service providers save on other aspects of safety prequalification freeing time and resources to engage in risk assessment.

If the host is concerned about safety prequalification limiting the number of bidders, then the host is 10 times more likely to risk assess the work to be contracted out. Here we find direct evidence of hosts weighing the costs and benefits of safety prequalification. Put another way, if the host is afraid that safety prequalification will be economically costly, the host is inclined to carefully analyze the safety-risks-and-benefits of prequalification by assessing the inherent safety risks of the work to be let.

The model in Equation 9 also indicates that with each percentage-point increase in contacted work as a percent of all work, the host is 1.06 times more likely to risk assess the potentially contractible work. (In different units, a 10 percentage point increase in contracted work makes the host 1.6 times more likely to risk assess.) Thus, when contracted work is a main aspect of the host's operations, the host will more routinely risk assess the work to be contracted out.

Typically, in our data, the contractor's wages are lower than the host's wages. But in the few instances where the contractor's wages were the same as the host's, hosts were 7.6 times more likely to risk assess the work. One reason to contract out work is to save money often by contracting to lower-paying employers. But hosts also contract out to get specialists who know how to handle complicated or dangerous work. When the wages of hosts and contractors are the same, hosts are more likely to risk assess the potentially contractible work to see what are the dangers entailed and who can best handle those risks—the host or the contractor.

Finally, we tested to see if the number of contract workers (as opposed to percentage) predicted safety risk assessment as an economy of scale variable controlling for the aforementioned other factors. We found that this variable was marginally statistically insignificant.

The overall picture described by the risk-assessment model in Equation 9 is one where hosts risk-assess potentially contractible work when the host is larger, the host is using other cutting edge safety management tools (such as safety prequalification services), the host is concerned that prequalification will limit the number of bidders, the amount of contracted work is relatively large and/or the work may be technically

demanding or dangerous.  All of these factors support the notion that hosts do and should

weigh the economic and other benefits of safety prequalification against their costs.

# Factors that should encourage risk assessment of contracted work
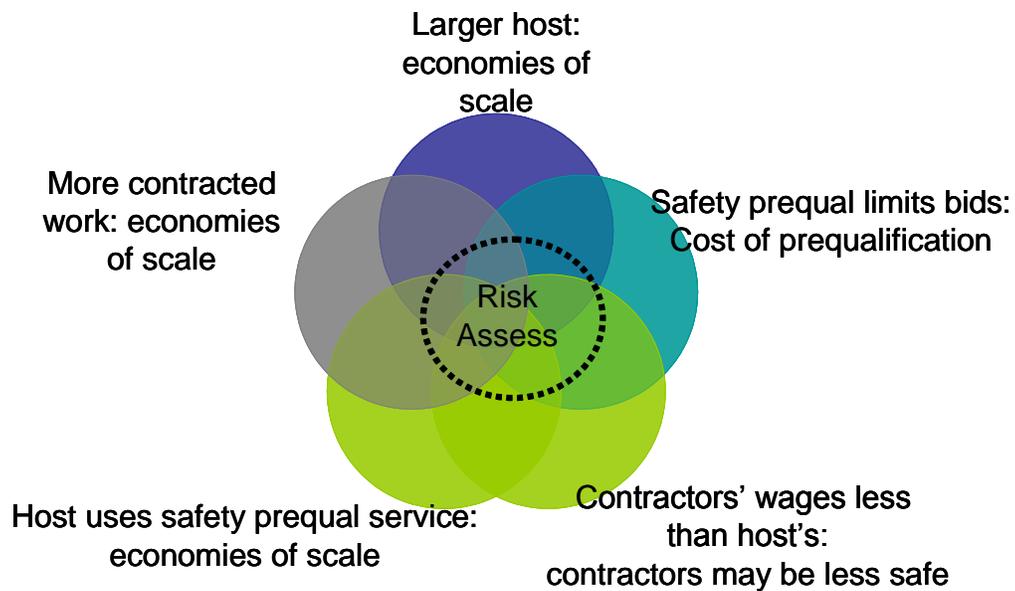


**Figure 8: Factors that should encourage hosts to risk assess work to be contracted out**

Figure 8 summarizes the general factors that should encourage the host to undergo the time and expense to safety risk assess work to be contracted out. all other things being equal, larger hosts should exploit their economies of scale in administration to implement systematic risk assessment of jobs. Controlling for the size of the host, the more work contracted out as a percentage of all the host's work, the more the host should risk assess this work. The more the host fears that safety prequalification will limit bidding competition, the more the host should risk assess the work in order to see if the inherent risks warrant safety prequalification (as well as to enhance the effectiveness of safety prequalification should it be done. The less the contractors' wages are relative to the host's, the more likely the contractors' workers will be less safe without safety prequalification. And finally, one of the benefits of using a safety prequalification

service is that the economies of scale provided by such services may help finance safety

risk assessment and the regularization of safety prequalification associated with such

services may naturally lead to more safety risk assessment as part of the overall routine of

safety prequalification.

In this weighing summarized in Figure 8, both the costs and the benefits will be a

function of the dangers of the work under consideration. One major corporation provided

us with a description of their company's effort to balance the costs of safety

prequalification against the benefits of enhanced safety by tying safety prequalification

standards to the assessed risk of the work to be contracted out.  Their policy divides

safety risks into low—medium—high with correspondingly rising safety prequalification

standards.  This company's safety prequalification guidelines are as follows:

Low Risk

Low Risk contractor/subcontractor EHS [environmental health and safety] screening

criteria include:

 Overall ability to perform work in a manner that addresses and mitigates risk factors

- Presence of an EHS Policy

- Verification of appropriate insurance and workers compensation coverage

- Reputation – a qualitative indicator of ability to perform responsibly

Medium Risk

Medium Risk contractor/subcontractor EHS screening criteria includes these additional

criteria in addition to those identified under the low risk category:

- Presence of an EHS Management System (e.g. ISO 14001, a proprietary internal EHS management system)

- Training - The contractor must provide evidence of all EHS training required by international / federal laws and/or regulations to their personnel

- EHS Performance – at minimum review:

  o Fee penalties over a three year period

  o Regulatory citations over a three year period

  o Consent decrees entered into with EHS regulators

  o Experience Modification Rate or EMR (Workers Compensation – US Only)

  o Number of work related injuries/illnesses/fatalities (rates)

- References – may be useful in certain circumstances

- Substance abuse policy

High Risk

High Risk contractor/subcontractor EHS screening criteria includes these additional criteria in addition to those identified under the low and medium risk categories:

Presence of an integrated EHS and quality system (combined ISO 9001/14001 system)

- Participant in the OSHA Voluntary Protection Program (VPP)

- Participant in US EPA National Performance Track Program or State

- EHS Programs including compliance and audit

- EHS compliance commitment from company officers or designee

Thus, this company raises the safety prequalification bar as the risks of the work rises. Readers should notice that the degree of danger can vary not only across projects and jobs within a site or a company, but also across companies and industries. What "low risk" or "high risk" entails will be relative to the specific activities of differing companies. So the above policy can only serve as an example of how to scale safety prequalification standards to varying degrees of safety risk. Nonetheless, the general principle remains: safety prequalification is designed to separate safe from unsafe contractors *given* the inherent risk of the work to be contracted out. Varying levels of inherent risk should lead to varying levels of safety prequalification standards in order to balance the safety benefits of prequalification with their costs.

## The Tradeoff between Inexpensive Safety Prequalification and Drilling Down to Determine Contractor Safety Culture

When asked to rank the most important reason to safety prequalify contractors, the majority in our survey of host employers said it was "to align the contractor's expectations and safety culture with our own company's work and safety culture." Safety culture implies a thorough company-wide commitment to worker safety. Hosts are looking for contractors with that commitment. However, it is not always clear how to identify such a commitment through simple, objective measures. Some measures have been suggested such as whether or not contractor management compensation is tied to safety outcomes. However, in our survey of host safety executives regarding the key contractor attributes that lead to safe outcomes, the role of contractor management compensation was not ranked highly. (See
Figure 9.)

1. contractor management compensation is tied to safety performance
2. contractors are required to report safety incidents to host management
3. host management compensation is tied to safety performance
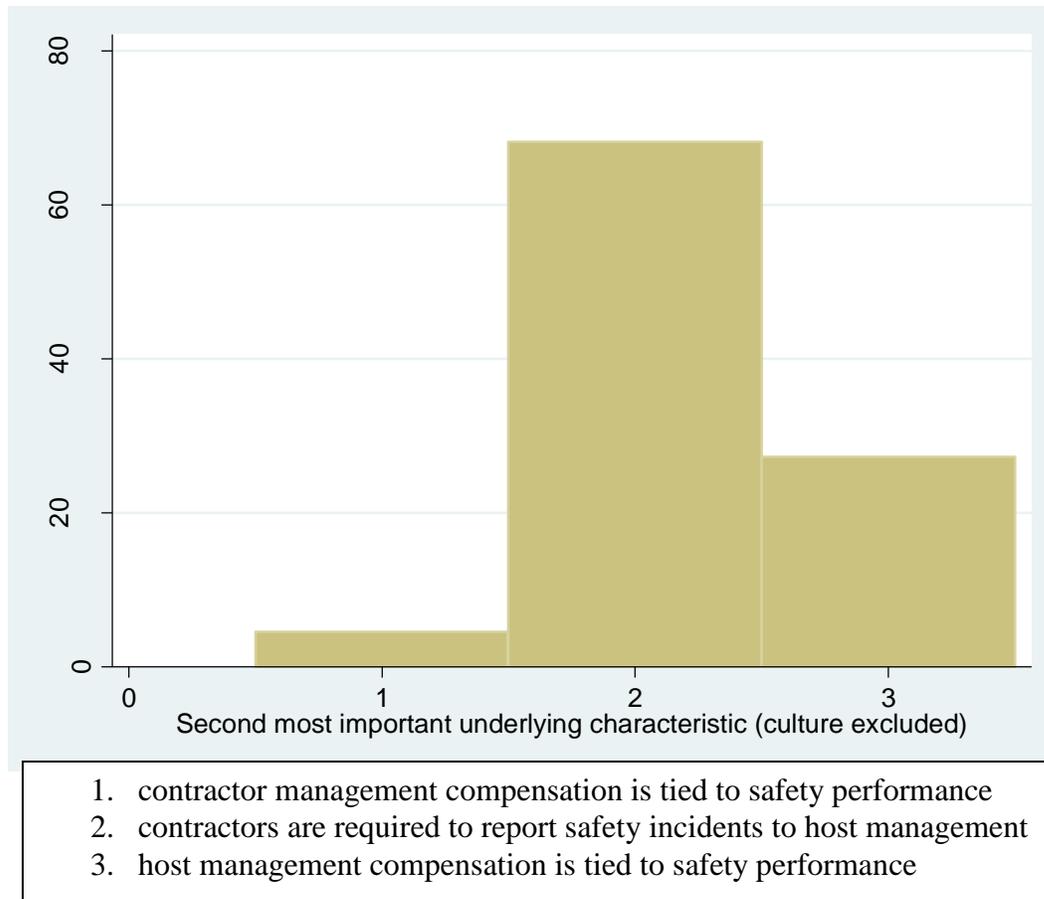
**Figure 9: Underlying host and contractor conditions needed to make safety prequalification work excluding the safety cultures of the host employer and contractor**

The alternative to a limited number of relatively inexpensive-to-acquire indices of contractor company culture is simply to assume if contractors have been safe in the past, they must have a good safety culture. This is the proof-is-in-the-pudding approach and data from our chapter on predictors of contractor safety provide some encouragement for this approach. For instance, Figure 10 below shows that current lost workday injury rates are well predicted by past lost workday injury rates. This was discussed in detail in our previous chapter. The problem is: this inexpensive predictor can be imprecise in two ways—first, not all the outcomes are well predicted by the past—some points are not on or close to the predicted line; and second, the predicted-injury-from-past-injury line has

less than at a 45 degree slope suggesting there is not a one-to-one correspondence of present injuries with the past injuries. We discussed this at length in our previous chapter regarding how contractors may learn from past mistakes. So inexpensive indicators may not do if the benefits of enhanced safety are high.
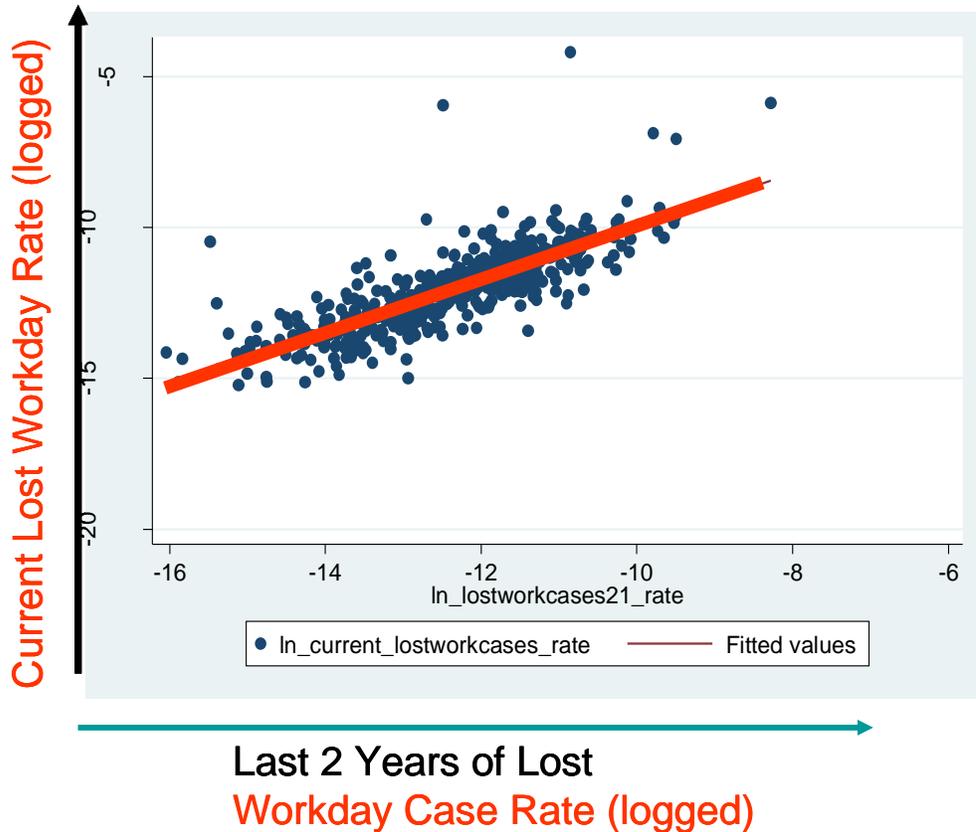


**Figure 10: Current lost workday injury rates predicted by past lost workday injury rates**

If you cannot get inexpensive direct measures of contractor safety culture, and if inexpensive indirect measures have some looseness in them, the alternative is to pay for more expensive measures of contractor safety culture. This requires office and field visits (audits) where representatives of the host can examine how the safety policies of the contractor play out at the workplace. When we asked host safety executives what

direct field observations were likely to be the most telling, they ranked the following

characteristics in order of importance:

| | |
|---|---|
| 1 | Workers wearing the appropriate personal protective equipment |
| 1 | Appropriate work permits are available (e.g. Hot work, confined space, electrical, etc.) |
| 3 | Field auditor concludes that management is (or is not) truly committed to safe work procedures |
| 4 | Workers are (or are not) aware of appropriate safety procedures |
| 5 | Contractor familiar with the site emergency plans |
| 5 | Housekeeping in the contractor's area is adequate |
| 5 | The field auditor observes a particularly or unusually safe or unsafe activity |
| 8 | Field auditor concludes that the contractor is generally working in a safe manner |
| 9 | Contractor has the appropriate material safety data sheets available |

Table 8: Ranking of importance of various direct field observations of contractor safety

Interestingly, the two highest ranked characteristics were objective

observations—were workers wearing the right safety equipment and were appropriate

permits available? A field auditor's conclusion that the contractor was committed to safe

work procedures was ranked very high but not at the top. We take this to mean there is a

desire among hosts that measures of safety culture be objective. The problem with

subjective assessments of safety culture is that they may vary with the field auditor and

give a less than clear signal to contractors regarding what is demanded of them.

Nonetheless, it may be that ultimately hosts seeking to align contractor safety culture

with their own will have to rely upon expensive and often subjective measures of safety

culture. To some extent, the hunt for safety culture among contractors may end up with

the methodology of "I can't measure it but I know it when I see it."

So the tradeoff between inexpensive safety prequalification and expensive field

audits to determine contractor safety culture may entail, at the inexpensive end, a choice

between direct measures of safety culture such as managerial compensation schemes and indirect proof-is-in-the-pudding outcome measures of past accidents predicting current accidents, while at the expensive end of field audits, the search for contractor safety culture may entail a choice between objective observations and subjective assessments. Thus, while contractor safety culture is key to aligning contractor safety with host expectations, how to measure contractor safety culture is a key challenge in developing a contractor safety prequalification program. In the next chapter when we talk about how to test for the effectiveness of any implemented safety prequalification program, we will argue that the answer to this dilemma is in continually and broadly testing the efficacy of alternative measures of contractor safety culture through an effective monitoring program of contractor safety outcomes on host sites.

## *The Tradeoff between Pass-Fail Safety Standards and Point Systems*

As far as we can determine, at a formal level, current safety prequalification standards primarily involve pass-fail or pass—warning—fail scoring systems. A set of standards are established. They may be calibrated to the safety demands of the work under consideration. Contractors going through the safety prequalification process are then qualified (or "activated") when they pass these standards. Alternatively, contractors are scored on a one-two-three or green-orange-red standard where the three's or red-flagged contractors have failed; the one's or green-flagged contractors are qualified, and the contractors in the middle might be considered by the host but with qualification or caution. That caution might then entail some sort of safety risk mitigation plan should the contractor come on site.

Also, invariably, the safety prequalification schemes we examined also had exceptions that were possible in the case of an emergency job where a contractor is needed immediately, or in the case of a local monopoly where no other contractor was capable of doing the needed work.

In contrast to these formal systems, we also uncovered informal contractor safety prequalification systems where the contractor was rated on safety and that rating was then provided to those doing procurement as one additional fact regarding the potential contractor. In these cases, how procurement weighed safety considerations against other considerations was informal and ad hoc.

In principle, we believe an alternative system is possible where contractor safety prequalification is formally part of a point system for selecting contractors. In this alternative points are awarded for price, safety capabilities and other possible factors including contractor reputation for quality, timely delivery of services, experience with the specifically needed work, etc. This "best value" type of procurement system is increasingly common in construction procurement although the specifics of the point systems can vary widely. How safety consideration would be weighted against price and other considerations is beyond the scope of this report. Here we notice the advantages of formalizing what are essentially informal point systems, and we also note that while point systems help hosts balance safety against cost, these point systems can also obscure signals hosts need to send to the contractor community about the importance of safety. In cases where contractor safety prequalification is an informal input to procurement rather than a formal pass-fail or pass—warnings—fail standard, there are benefits to formalizing safety's role in contractor procurement. If the weight given to safety relative to other

factors is formalized, then, over time, the host can better measure the effectiveness of their program. (We will discuss measuring program effectiveness more in the next chapter.)

The tradeoffs discussed above could be put into a best-value point system. In creating a scalable model of safety prequalification, the underlying tradeoff is between the safety costs of an unsafe contractor combined with the dangers inherent in the work itself weighed against the economic costs of safety prequalification which include both restrictions on bidding and the administrative costs of prequalification. In a pure best value system, contractors are not prequalified. (There are hybrid systems where they are.) Safety and other standards are not imposed through contractor exclusion but through points granted for each factor. Thus, there is no tradeoff, per se, between safety standards and bidding numbers. In its place is a flexible scheme of weighting on a job-by-job basis the relative importance of safety and price. This is the great virtue of the point-system approach.

The major drawback of a point system or best value approach is that it does not send a clear market signal to the contractor community regarding what overall safety standards and contractor safety culture should be. By trading off safety against price, best value systems say to contractors that you need not be safe if you can be cheap. In the short run, it is in the host employer's interest to be able to choose between safe-expensive and less-safe-cheap depending on the job at hand. But in the long run, it is in the host employer's interest that the entire contractor community improves its safety capabilities making safer work more common and less expensive to obtain. This long run goal is better achieved by sending a clear signal to the contractor community regarding

the importance of safety culture and all that might entail. Pass-fail standards as opposed to tradeoff point systems send a clearer message regarding what is needed by the hosts. So while best value point systems can incorporate many of the tradeoffs between safety and cost, it also creates a tradeoff between the short run immediate host needs *given* the general safety capacity of the contractor community, and the long run development of contractor community safety capabilities.

## The Tradeoff between Solitary-Host and Multiple-Host Contractor Prequalification

As discussed in earlier chapters, some hosts do their own contractor safety prequalification while other use third party services such as area safety councils and safety prequalification service companies. The primary reason not to use a third-party safety prequalification program is when the host views their own prequalification program as sufficiently superior to others as to be a proprietorial competitive advantage. Hand-in-hand with this, the host may view third party programs as diluting the effectiveness of their own program. Lastly, in-house safety prequalification programs may give the host managers a sense of ownership that helps facilitate a buy-in to safety prequalification from various interest groups within the host company.

The primary reason to use a third-party safety prequalification party—either an area safety council or an prequalification service company—is they save on administrative costs. The primary cost saving is allowing contractors to go through one prequalification program to meet the demands of multiple host employers. As mentioned above, multi-host-employer safety prequalification programs by spreading the fixed costs of prequalification across more potential work encourages more contractors to participate

and allows for longer and more often renewed prequalified bid lists. All this helps sustain competitive pressure on bidders holding down host procurement costs. But a second important benefit of multiple-host-safety prequalification is that it sends a relatively uniform and clear signal to contractors regarding what is required of them to compete in the segment of the market these hosts occupy. We have heard form industry observers that contractors find it difficult to adapt to differing host safety expectations. Contractors find it difficult to assess what the industry views as truly safe. Obviously each host's work site has unique characteristics which require special safety procedure. And each host has a unique company history that makes for distinctive company cultures including safety cultures. But flexible uniformity is needed to signal to contractors what to do and what to prepare for. By using multiple-host-safety-prequalification-systems, there is some institutional pressure towards uniformity of standards even as these systems seek to build into themselves the ability to customize standards for the needs of each host. Thus multiple-host systems create flexible pressures among hosts (and even among worksites within hosts) to create standardized procedures that in turn help contractors come up to those standards.

In our survey we found that hosts that did not use multiemployer prequalification programs were more likely to fail contractors in the safety prequalification process. This might imply that single host prequalification programs are more rigorous, but we think this more likely indicates that the clearer signals generated by the leverage and uniformity of multiemployer prequalification programs induces contractors to come up to the safety standards set by those programs. We also found in our survey that hosts that did not use multiemployer prequalification programs were more likely not to safety

at least in some cases because to do so would overly limit the

pool of needed bidders.  So even if single host safety prequalification programs are more

rigorous, that rigor comes at the cost of not using it as often in procuring contactors.
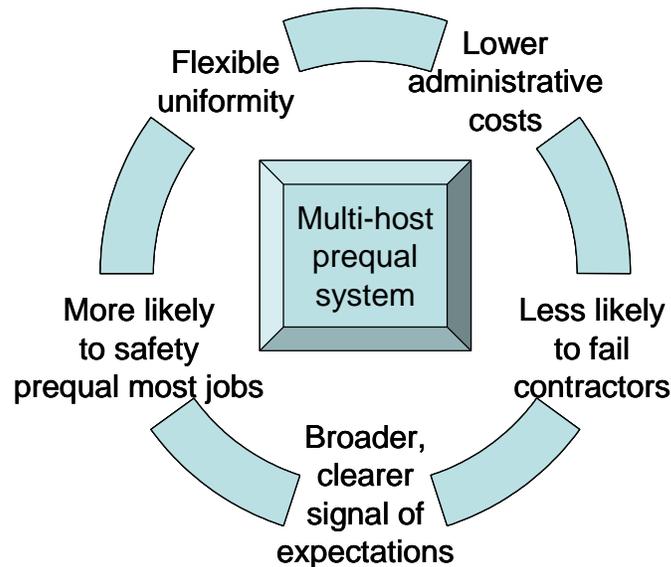


**Figure 11: Advantages of multi-host contractor safety prequalification systems**

Figure 11 summarizes the advantages of multi-host contractor safety

prequalification systems.  As long as those systems provide sufficient flexible uniformity

to customize standards to the needs of the various participating hosts, these multi-host

programs provide considerable advantages  Thus, while the tradeoff between single and

multiemployer prequalification approaches is governed by a tradeoff between local

control vs. lower administrative costs, this tradeoff also appears to entail a greater

limitation on bidder numbers under the single host approach with a consequent greater

reluctance to always apply safety prequalification in contractor procurement procedures.

This, in turn, weakens the signals hosts want and need to send to the contractor

community regarding the safety standards that should be generally adopted by contractors.

## The Tradeoff between Contractor Prequalification and Contractor-Worker Prequalification

Contractor safety is partly a function of the safety of that contractor's workers. Hosts may well want workers to prequalify for the host's worksite as well based on drug-and-alcohol testing, safety training, criminal background checks and other criteria. To what extent should contractor prequalification and worker prequalification be combined and to what extent are these separable issues?

The key to the tradeoff between contractor safety prequalification and contractor-worker safety prequalification lies in the degree to which the contractor community serving the host fully shares a worker community. At one extreme, if the workers who will be employed by the contractor selected by the host are the same workers who would be employed by any other contractor the host might select, then there are economies of scale in prequalifying the workers once regardless of which contractor gets selected. At the other extreme, if one contractor will bring one set of workers and a second contractor will bring an entirely different set of workers, then there are no economies of scale in combining the processes of contractor and worker prequalification. Overlap creates economies of scale while complete separation eliminates any possibility of capturing administrative economies in contractor-worker joint prequalification programs. At the moment, in the United States, area safety councils are the institutions attempting to capture economies of scale in joint contractor-worker safety prequalification, and the economic basis for their doing so is the concentration of similar companies in the same

industry close together in one region served by one contractor community and one relevant labor market. Area safety councils make sense when a particular industry using similar contractors is located in the same area. One might think of this as capturing a geographic economy of scale. When industries are more geographically diffused, contractor-worker joint prequalification is less effective.

Also, when workplace safety issues are closely intertwined with workplace security issues, contractor and worker safety prequalification may go hand-in-hand. A host may require security clearances, or legal work status, or a criminal background check and want the contractors to draw workers only from a pool the host is sure meets these criteria. In this case, there may well be significant economies of scale in interweaving the administration of worker and contractor safety prequalification. However, note that these security conditions fit our geographic economy of scale generalization above. In this security scenario, because the host wants the contractors to draw from an approved pool of workers, overlap is assured. So security worker prequalification is just a special case of the overlap-separation rule governing the tradeoff between contractor-only vs. joint prequalification approaches.

The contractor safety prequalification service provider is not exploiting a geographic economy of scale but rather a information economy of scale rooted in saving on the administrative costs in determining if a contractor meets safety standards shared by more than one host employer. This type of service provider is not rooted geographically and is more appropriate for hosts that are not trying to meld contractor and worker prequalification and hosts that are concerned with uniform prequalifying procedures across a broader landscape. Both the area safety council model and the

prequalification service company model meet the general goal of lengthening the list of qualified bidders and thereby maintaining competitive pressure on contractors.

## The local area safety council vs. prequal service provider choice:



**A** No economies of scale in local area councils

**B** Considerable economies of scale in local area councils

**C** Intermediate case
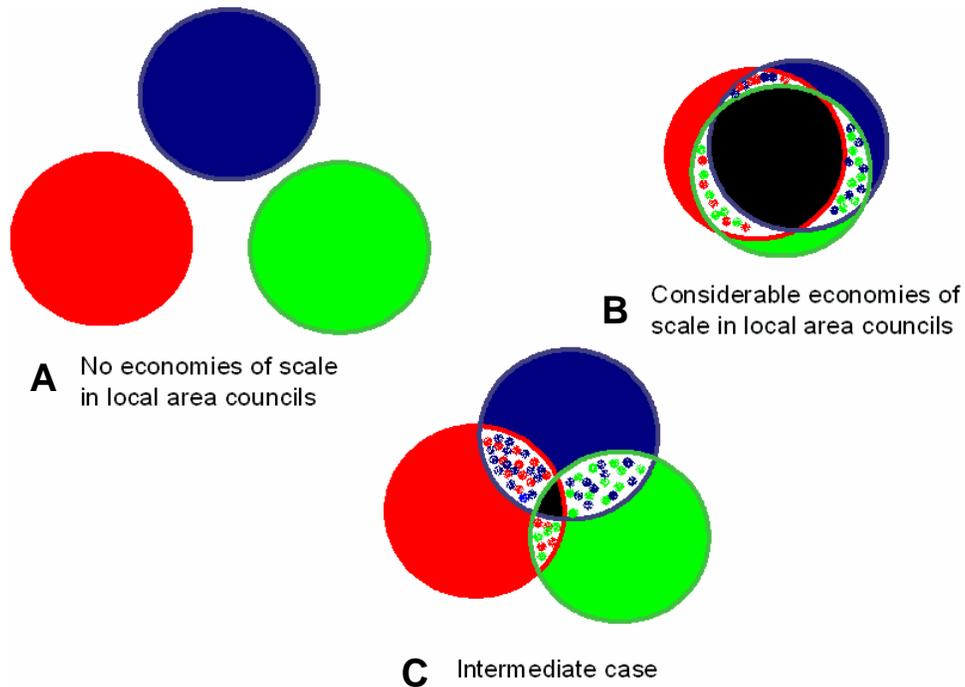
**Figure 12: Calculating the choice between third-party safety prequalification service provider and local area safety council**

Figure 12 summarizes the choice between the advantages of a local area safety council and a third party safety prequalification service provider. Each colored circle represents the workforce of three separate contractors (contractors red, blue and green). In Case A, no worker working for the red contractor works for either the blue of green contractors. In Case B, the opposite is true, the majority of workers work for all three contractors as represented by the black shaded area. Also many workers work for two if not all three of the hypothetical contractors. And a minority of workers fail to work for more than one contractor. In the intermediate Case C, there is some overlap of workers

between contractors but it is limited and only a minority work for all three contractors. These logically distinct possibilities describe the circumstances where local area councils make the most sense. In Case B, all the contractors share most of the workers and most of the contractors share most of the remaining workers. So prequalifying workers in the same system that prequalifies contractors create economies of scale. In Case A there is no overlap and no economies of scale. Most situations will be like intermediate Case B with some overlap. The amount of overlap will determine the cost savings available in doubly safety prequalifying both workers and contractors in the same system. Hosts should examine potential overlap in choosing between alternative multi-host safety prequalifying systems and recognize that over time, these competing models may merge towards each other to some extent.

## *Summary*

We have discussed the tradeoffs that shape how a model of contractor safety prequalification should be built. Central to these tradeoffs is an economic balancing of the benefits of safety prequalification and its administrative and economic costs. Figure 3 describes the basic decision making that is involved in balancing these costs and benefits. If there are no or very limited safety risks in the work to be contracted out, then almost by definition, the administrative and economic costs will outweigh these nonexistent or very limited benefits. But if there are benefits to be had from enhanced contractor safety, then the costs of imposing contractor safety prequalification should be understood and weighted.

The administrative costs are rooted in the fixed costs of safety prequalification. If the contractor is a repeat provider of services to the host who has been and if selected,

will be on the host's site for considerable time doing substantial work, and that contractor has a known and superior safety record, then the host may choose not to safety prequalify this known entity. But if the benefits of safety are substantial, the host may yet prequalify simply because there are benefits and in this case the fixed costs of safety prequalification are low and can be spread over a long period and substantial work.

The amount of fixed costs safety prequalification entails faces the tradeoff between cheaper but more superficial measures of contractor safety capabilities and more expensive but perhaps better measures on contractor safety culture. Whatever the size of those fixed costs, they are spread across the number of jobs the contractor may potentially receive. Multi-host prequalification systems help spread those costs. The economic costs are rooted in the extent to which contractor safety prequalifications significantly limit the number of contractors bidding on the host's work. Bid lists that are short due to either rigorous safety standards eliminating contractors or due to administrative costs that deter contractors from participating reduce competitive pressures on qualified contractors. Bid lists that are long standing and short let contractors know about the limited universe of their competitors and may encourage implicit collusion in bidding. So while not periodically reevaluating prequalified contractors may save on administrative costs, it also may raise bid costs particularly when bid lists are short. Multi-host prequalification systems help relieve these tradeoffs by spreading the administrative costs of prequalification thus lengthening bid lists and making periodic review less expensive.

Balanced against these administrative and economic costs of safety prequalification are the benefits of enhanced safety. Here there are two basic

considerations. First, how inherently dangerous is the work to be done by contractors? The more central to potential safety risks on the host's site, the more benefits will the host reap by safety prequalifying contractors. Both type and location of work will influence its potential safety risks. Second, enhanced safety is not only a function of the safety risks of the host's work but also the safety capabilities of the contractor community. In the short run, contractor safety capabilities are given, but in the long run they can improve both based on innovations in technology and management and also based on clear signals from hosts that improvement is required. When hosts demand a certain level of safety practices, contractors will adopt these practices widely and the wide adoption of any given safety technology, training or management system will tend to lower its cost. So the cost benefit assessment of safety prequalification systems must include this dynamic element. Generally speaking, this dynamic of host signals leading to contractor response leading to falling safety costs is best implemented when the signal is clearly sent. Third party contractor safety prequalification service providers are one good way of making at least some signals to contractors clear and consistent.

Figure 13 summarizes the various safety cost-benefit tradeoffs that would rationally lead a host employer to adopt contractor safety prequalification. In our next chapter we will discuss how to determine whether the prequalification model adopted is working.
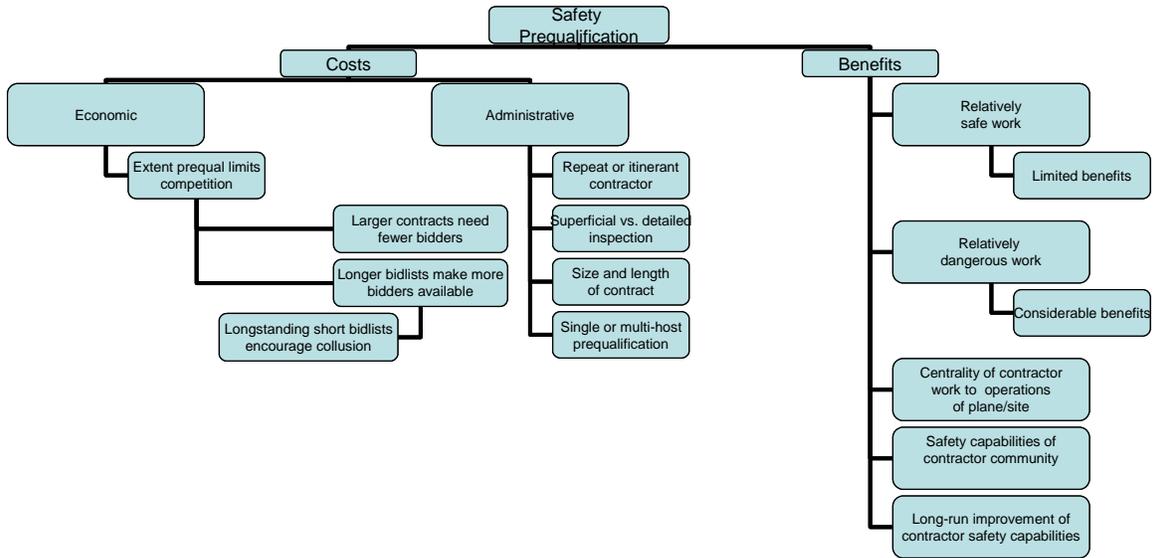
**Figure 13: Cost-benefit model of the choices driving safety prequalification**

# Chapter 5 Testing the Effectiveness of Safety Prequalification of Contractors

## *Introduction*

Safety engineering principles and host experience are the primary sources of information used to design contractor safety standards both regarding what past safety performance should be measured and what current contractor safety capabilities are important. However, in testing the effectiveness and refining the procedures of in-place contractor safety procedures, the proof is in the pudding. Contractor safety outcomes on host sites are the essential indicators of whether or not a contractor safety prequalification system is working and the extent to which it is improving safety outcomes. In this chapter, we will discuss the information feedback loops that are most effective in determining what safety outcomes have been generated by prequalification screening. We will argue that the sample size of outcome observations needs to be large in order to control for other influences on safety outcomes and in order to see through the fog of random events that necessarily enshroud workplace safety. It turns out that there are two tests of the effectiveness of contractor safety prequalification procedures—testing whether contractor safety prequalification is superior to no prequalification, and testing what procedures within the safety prequalification system are working well. In both cases, finding adequate control group data against which to benchmark the effects of contractor safety prequalification is difficult requiring creativity in information feedback loops and the gathering of other data.

Additional difficulties arise with an issue raised earlier with respect to the difference in etiology between high prevalence accidents that result most often in OSHA recordable lost workday occupational illnesses and injuries (OII) versus low-prevalence, high-consequence (LP-HC) events that tend to generate higher incidence of fatalities (Rosenthal, Kleindorfer and Elliott 2006). Collecting adequate metrics and control data is an inherently more formidable task in the face of LP-HC events, and so the demands for testing the effectiveness for any particular safety prequalification scheme also poses greater challenges. Liability concerns by firms also compete with root cause investigation (Rosenthal, 1997b), which can hamper the isolation of optimal metrics and thereby compromise the feedback loop which promotes organizational learning.

Whatever the power and effectiveness of any particular safety prequalification criterion, there is, over time, a half-life to this effectiveness. Contractor safety prequalification systems are quasi-Darwinian forms of competition. Safety standards select for certain contractors, and over time, those selection criteria will come to characterize most, if not all, within the contractor community put under these selective pressures. So criteria that once separated wheat from chaff will eventually no longer distinguish one contractor from another. Informational feedback loops within the safety prequalification system need to alert hosts to the continuing need to upgrade criteria as the contractor community upgrades their safety capabilities.

Due to the competitive pressures of natural selection, sometimes a species will engage in false advertising, as when a non-poisonous snake takes on the coloration of a poisonous snake; the Scarlet King Snake brilliantly mimics the coloration of the poisonous Eastern Coral Snake in order to benefit from the protection from predators that

the warning colors convey. Because contractor safety prequalification is a form of selective competition, some contractors may undertake the costs needed to meet the criteria by becoming safer while other contractors may seek to avoid those costs simply by misrepresenting themselves as safe. Contractor safety prequalification systems have to be continually refined in order to distinguish between the safe contractor and the mimic. Testing contractor safety outcomes on host sites relative to increasingly refined criteria over time is a key element in making the selective pressure of safety prequalification actually work. So the half-life of safety criteria due to contractor improvement and contractor misrepresentation makes the testing of the safety model not only a process of validation but of continued refinement.

Finally, there will be pressures to make contractor safety prequalification procedures proprietorial. There is value in safety prequalification criteria that work and those that devise and determine the usefulness of a given approach will have an incentive to profit from their innovation through the private use of the technique. However, private advantage in safety prequalification is trumped by the collective value of the information. The more information is shared among hosts either directly or through third party service companies, the more that information will be capable of distinguishing what works from what does not work. There needs to be an "open source" approach to safety prequalification with standard measures of context and outcome in order to maximize the information built into feedback loops. This open source approach may be difficult to implement in the context of private systems of safety prequalification and informational feedback loops.

## *Calibrating, Testing and Refining Contractor Safety Prequalification Systems*

While safety engineering and host/contractor experience are the basis for designing a contractor safety prequalification program, implementing that program entails calibrating the system to the specifics of the host's work, testing the effectiveness of selection criteria and refining procedures based on the lessons learned in the field. Testing requires informational feedback loops which span across contractors, hosts, cooperating hosts and third party prequalification service providers. There is also a role for government in assisting with the generation and collection of information. But because contractor safety outcomes on host multiemployer worksites must be linked to the safety criteria that got them there, most of the information collected from the worksite and looped back to the implementation of prequalification criteria must be privately collected. And just as there is many a slip twixt cup and lip, the movement of information from subcontractor to contractor to host-on-site to host-in-general to (potentially) cooperating hosts to (potentially) third party service providers provides multiple opportunities for information to be lost or garbled. So a basic challenge in testing and refining safety prequalification programs is implementing reliable information flows regarding how criteria are applied at the front end and what safety results occur at the back end

### Numerator and Denominator Data

With reliable information loops in place, the issue becomes how to measure safety outcomes. This creates both "numerator" and "denominator" problems. In the numerator are unfavorable safety outcomes including injuries, fatalities, catastrophes (i.e. connected,

snowballing accidents rather than isolated events), and near misses.  The denominator

needs to include measures of exposure to risk including the contractor's worker-hours on

the work site and simply the contractor's time on site.

These fairly straight-forward denominator measures of safety risk exposure need

to be handicapped by an assessment of the specific safety risks the contractor is

undertaking on the work site including exposure to risks by others.  We know from our

surveys of hosts that a risk assessment of contractor assignments is not always done.  In

our ORC survey of large employers, 16% said that they rarely or never assessed the

safety risks of work assigned to contractors while 17% of the hosts in the RMCOEH

survey of average-sized employers said they risk assessed the contracted work

infrequently or never.  This may, in part, reflect contracted out work that the host

generically believes holds little safety risk exposure.  But only 40% of the large hosts and

only 57% of the average-sized host said that they risk assessed contracted work usually or

always.   Data on contractor safety outcomes need to be weighted by the risk exposure

those contractors face.  Time on-the-job is a basic measure of exposure, but weighting

that time exposure by the risks entailed in the work is an important refinement needed in

"denominator" data.  The fact that hosts do not systematically rate the safety risks of

contracted work at the moment creates a challenge for adequately measuring and refining

the effectiveness of contractor safety prequalification systems.

Even when contractor work is risk-assessed, that assessment needs to be

quantified and these quantifiable measures of risk need to be implemented uniformly

across different assignments, on site, across sites within the host and across hosts where

host-cooperation or third party involvement are part of the safety prequalification system

and information feedback loops.  Considerable work needs to be done by safety professionals to develop such a quantifiable system of risk.  There will be an irreducible subjective element in quantifying job risks which will make the testing and refining of prequalification systems less precise.

A partial, short-run solution to the problems of lack of safety assessments and subjective elements in safety assessments is the development and collection of industry, occupational and task classification systems describing the location and type of work the contactor has undertaken.  Government industry and occupational categories are well developed and may be borrowed for this purpose, and worker compensation insurance schemes also have sought to measure risk based on describing the type of work undertaken.  Even very detailed industry and occupational descriptors, however, can conflate more and less dangerous work together muddying denominator data designed to capture true contractor risk exposure.  Over time, systems of contractor safety prequalification will have to enhance such measures by marrying them with an expanded use of risk-exposure-analysis data.

The risks to which the contractor is exposed are not simply a function of the technical facets of the work undertaken, but also derive from the larger context of firm organization and management, as well as by the broader economic and regulatory climate (Rosenthal, 1997a, Manuele 1997).    The host creates a context for this work based on the host's safety culture and the practical steps taken to implement that culture. Furthermore, the contractor's risks will be influenced by the behavior of other contractors on the job site.  Measures of communication between the host and the contractor, and communication between contractors are two-way streets influencing the safety risks faced

by the contractor. Denominator data need to capture the institutional as well as the engineering aspects of the contractor's assigned tasks in order to fully measure the risks to which the contractor is exposed.

In order to assess safety outcomes, numerator data on injuries, fatalities, catastrophes and near misses need to be collected for the on-site experience of each prequalified contractor including subcontractors who may have been prequalified by the contractor outside the host's safety prequalification system. Ideally, all subcontractors have been prequalified through the host's system, but that will often not be the case. This will create substantial problems in maintaining informational feedback loops and in applying consistent numerator and denominator measures of outcomes and risks. Setting this confounding issue aside, there are standard measures of injuries that may be inadequate to the task of measuring the effectiveness of safety prequalification systems. Currently, our survey indicates that lost workday injuries are the focus of injury-based contractor screening. This can fairly easily be supplemented with data on average days lost per lost-day case. These are widely used, well understood injury definitions that can be relatively uniformly applied across host work sites. However, they may not capture what hosts are seeking to filter out in contractor safety prequalification.

Assume for the moment that contractor safety prequalification is designed to forestall serious injuries, deaths and catastrophes (a widespread accident harmful to workers and property). The use of lost workday data, which is valuable for assessing and reducing the risk of OII, is likely to be inadequate in the case of RMP accidents, which tend to be more tied to systemic and multiple barriers being compromised rather than the breaking of single barriers that tend to characterize OII (Rosenthal, Kleindorfer

and Elliott 2006). Days-away-from-work cutoffs at (say) 3, 5 10 and 20 days of work lost may be better measures of accident seriousness than days-away of any length supplemented with an average length of days lost. In testing and refining contractor prequalification systems, multiple measures of accident seriousness should be collected and statistical analysis applied over time to see which is most predictive of future serious events. The challenges to generation of reliable metrics for prevention of LP-HC events have been well documented (Rosenthal, 2002; Rosenthal, Kleindorfer and Elliott 2006). The U.S. Chemical Safety and Hazard Investigation Board's mission, like that of EPA's Risk Management Program (RMP) and OSHA's Process Safety Management (PSM) regulation, is the prevention of major chemical releases (Rosenthal, 2002). Part of the Board's responsibility is to investigate root causes of chemical releases and assessing hazards that pose risk for such release. Rosenthal (2002) maintains that the Risk Management Accident Reporting System (RMP*INFO), EPA's online database holds particular promise, with certain modifications, for generating the metrics required for such root cause analysis and hazard assessment. Currently, the RMP*INFO system collects the 5-yr accident history (numerator data) on processes covered under the EPA's RMP standard (denominator data), establishing an incidence rate. Rosenthal (2002) proposes, that annual, rather than 5-yr data be submitted to RMP*INFO system, and that annual duration of plant operation be collected, so as to refine the Board's ability to assess such risk in the short run.

Assume now that the purpose of contractor safety prequalification is to forestall catastrophic events defined as accidents that involve many people, property damage, serious injuries and/or fatalities. Under such objectives, it may well be that the best

predictor is events that involve multiple injuries or fatalities. So denominator data should be collected on multiple-party events which include measures of property damage. And because the goal is to avoid these catastrophic events, numerator data on catastrophic outcomes should also be collected. These numerator outcome events should be defined as injuries that involve a threshold number of people, a threshold number of workdays lost per group, a threshold value of property damaged and any case involving two or more fatalities. The purpose of this data collection is to measure both in the past and during the present collective outcomes that entail "catastrophic" events.

As discussed in a previous chapter, host safety officers have focused on fatalities as a predictor of future serious events including future fatalities and future catastrophic events because a worker death is unquestionably a serious outcome and worker deaths do not go underreported. However, again as discussed previously, fatalities are sufficiently uncommon as to be poor predictors of themselves. In order to remedy this shortcoming, "near-miss" serious or fatal events should also be recorded (Rosenthal Kleindorfer and Elliott 2006). We all have the experience of a near-miss driving where a car ran a red light or swerved in a lane and nothing happened but something very serious could have happened. Combining past near-misses with past fatalities could enhance this combined measure as a predictor of current serious, fatal or catastrophic events. Obviously, the problems with near-misses are two: first, there is necessarily a subjective dimension regarding whether a near miss ever took place. Imagine disagreements between a driver and a back seat driver over whether the driver had weaved across lanes enough to qualify as a near miss. Second, to the extent that past near-misses become a selection criteria for current contractor selection, contractors will have an incentive to underreport a

phenomenon that is easily underreported. This could even prove perverse as the better contractor (or at least the more honest contractor) might report his near misses leading to the selection of the worse (or less honest) contractor who hides his near misses.

So in assessing the effectiveness of safety prequalification systems, near misses should be in the numerator measuring outcomes, but in so doing, they are likely to become selection criteria, themselves which will in all probability lead to their being underreported. Fortunately, because the informational feedback loops designed to test and refine the effectiveness of safety prequalification systems are based on events at host sites, there may be some observers who do not have an incentive to hide near misses. Host employer representatives and other contractors may not have an incentive to hide near misses, but the subjective character of near misses will still muddy the informational feedback loop as one observer, one site supervisor, one host may be more apt to call something a near miss while another set of observers may be less inclined to make that call. Thus, in seeking to measure potential serious or catastrophic events as opposed to actual such events, interest and subjectivity are the costs paid for increased observations and statistical pliability.

### The Cost of Prequalification-Safety Feedback Loops

The foregoing discussion of numerator data on safety outcomes and denominator data on safety-risk exposure all embedded in feedback loops circling between the prequalification stage and the work-outcome stage of contractor safety prequalification sets aside the question of how much these information flows cost. In testing the effectiveness of safety prequalification systems, we need to consider the cost of those tests relative to the benefits of contractor safety prequalification. This is made daunting

by the fact that we cannot fully know those benefits until we measure these systems'
effectiveness.  Catch 22.

The way forward through this dilemma is to assume that there are positive
benefits and then test for them in the context of a judicious concern for costs.  As
subcontractor layers deepen on the host's worksite, reliable feedback loops will become
more costly to implement and insure.  Simply requiring contractors to report accidents is
insufficient especially if innovative measures of injuries or near-miss events are to be
recorded.  Hosts must take responsibility for accurate reporting and this entails
observational if not supervisoral costs.  As contractor tenure shortens on host sites,
informational feedback loops become more expensive due to each new contractor having
to come up to speed on how to feed information into the loop.  As feedback loops span
subcontractors to contractors to host site representatives to host general offices to
cooperating hosts and to third-party prequalification service providers, the lengthening of
these loops increases costs associated with ensuring that there is no break in the
communication system.  Finally, more innovative or subjective numerator and
denominator data seeking to measure collective events or near misses or contractor
culture, will be more costly to systematically and uniformly collect.  These may be better
measures of outcomes.  They may be better predictors of outcomes.  They may better test
and measure the effectiveness of contractor prequalification systems.  But they will be
more costly to collect.  A judicious balance must be weighed between the benefits more
precise measures of predictiveness and effectiveness, on the one hand, and more
expensive information on the other.  This balance will not be permanently set.  As safety

prequalification selective pressures drives the evolution of contractor safety behavior, the measures designed to track that behavior will have to evolve.

All of these measures designed to track and test the efficacy of contractor safety prequalification systems must be constructed within the framework of knowable versus unknowable uncertainty. Knowable uncertainty entails stochastic events that you can model. Deep uncertainty entails events you cannot model and cannot know neither for certain or in a probabilistic sense. Imagine a six-sided die inside a black box. Shake the black box and the number that comes up is displayed on a screen on the top of the box. You cannot know what number will come up next. But you can know that over the long run, the number (say) four will come up $1/6^{th}$ of the time. This is knowable uncertainty. Now imagine that same black box has a die in it with an unknown number of sides. Shake the box and a number is displayed. You not only cannot know what number will be displayed this time, but over the long run you cannot say how often the number four will appear—not as long as you do not know the shape of the die.

Similarly, in risks associated with work, we need some understanding of how dangerous the work is from an engineering perspective. Handicapping the risk exposure of contractors and assessing the safety outcomes of contractor safety prequalification systems is more than a matter of gathering information regarding the contractor's past outcomes and current safety capabilities. And assessing effectiveness is more than benchmarking outcomes under contractor safety prequalification and absent prequalification. Another key benchmark is assessing outcomes relative to what one would expect based on what we know of the physical risks of the work. Thus, the information loops attached to safety prequalification systems in order to assess their

success must contain not only information about contractors but also information about the work contractors do.  This was discussed above under the rubric of handicapping risk exposure by the danger of the work.  There it was pointed out that many hosts do not always or even often risk-assess the work contracted out.  Just like not counting the sides of a die, if you do not risk assess the work to be let, then you are not well positioned to benchmark actual outcomes against expected outcomes.  You will not know whether a good or bad outcome is due to the safety selection process of the fickle throw of the dice.  Risk assessment is a cost of testing the effectiveness of contractor safety prequalification systems.

## Sample Size, Heterogeneity and Measuring Success

Statistically analyzed success of safety prequalification systems need not only be benchmarked against expected outcomes based on chance but also need to be based on a sufficient sample of observations.  The number of favorable and unfavorable contractor outcomes will be dependent upon the scope of the safety prequalification system.  Here economies of scale are paramount.  As one moves from site feedback loops to small host internal feedback to large host internal feedback to feedback across host employers through host cooperation or the auspices of a prequalification service, the sample size grows.  This is good because it facilitates statistical analysis in separating out systemic good (bad) performance of contractors due to effective screening from simply good (bad) luck.  On the other hand, as the feedback loops encompass more work sites, contractor types, locations and industries, the heterogeneity of work and safety exposure increases risking error associated with comparing apples with oranges.  There are a host of statistical techniques designed to address this problem, all of which rely upon indicators

of potential sources of heterogeneity of risk and circumstance. So there are two keys here for successful testing of the effectiveness of a prequalification system. First, to the extent the system spans more work, it will be easier to accurately measure successful aspects of the model and reinforce what works. Second, to the extent that the system encompasses different contractor safety circumstances, the feedback loops need to mark and measure those differences. Typical control measures for heterogeneity that need to be captured by the informational feedback loop include markers for the task, occupation, company, location, industry, regulatory environment, labor market conditions, dates of work and length of contractor engagement. On balance, the cost of collecting control variables to adjust for increased sample heterogeneity are strongly offset by the benefits of larger sample size in permitting a detailed statistical examination of the effectiveness of the safety prequalification system.

## Two Tests of Safety Prequalification Effectiveness

There are two tests of the effectiveness of contractor safety prequalification procedures. There is an overall test of whether contractor safety prequalification is superior to no prequalification, and there is the detailed test of what specific procedures within the safety prequalification system are working well. Each test has distinctive challenges rooted in establishing benchmarks against which to measure overall and detailed effectiveness.

**Overall Effectiveness.** The obvious benchmark needed to test the overall effectiveness of contractor safety prequalification systems is data on safety outcomes on multiemployer sites that are comparable in risk exposure and do not use safety prequalification. The problem is that, at this point in time, in the United States, there are

no public data on contractor safety outcomes under these circumstances. Furthermore, the informational feedback loops established by a prequalification system necessarily involve hosts that do safety prequalify. So again we encounter a catch-22: needed benchmarking data to test the effectiveness of safety prequalification systems typically cannot come from within those systems and are not available from without.

The way forward through this dilemma involves partial solutions. To benchmark the overall effectiveness of safety prequalification systems we need either here-and-there comparisons of worksites that do not prequalify and worksites that do. Or we need before-and-after data on worksites that previously did not safety prequalify and now do. Particularly during the transition to safety prequalification, these data may be partially available. Hosts with multiple sites may begin safety prequalification at one plant prior to another providing the potential for here-there comparisons. The problem here is that the period available for comparison may be short as usually there are institutional pressures to adopt safety prequalification company-wide once at least on comparably dangerous work once the technique is adopted anywhere within the company. Scientists love controlled experiments, but nobody loves being the guinea pig.

Nonetheless, there is often work within companies that is not safety prequalified. Table 9 shows the distribution of the percent of all contractor work that is prequalified within our two surveys. In both the average company RMCOEH survey and the large company ORC survey, just under half the host employers safety prequalify all of their contractors. Around 5% to 10% do not safety prequalify any contractor work. (We are confident that this figure is substantially higher in the real world simply because many host employers who did not respond to our survey may have chosen not to respond

because they do not safety prequalify contractors.)  But the number who do not safety

prequalify is not relevant to our purposes here.  If they do not safety prequalify at all,

they will not easily be integrated into a system designed to test the effectiveness of

contractor safety selection.  Our focus here is in that half of the contractor work in

companies that do safety prequalify that is not safety prequalified.  Can this serve as the

source of benchmark data to test the overall effectiveness of safety prequalification

systems?

| Percent Prequalified | Number of Hosts | | Percent of Hosts | |
|---|---|---|---|---|
| | RMCOEH | ORC | RMCOEH | ORC |
| 0 | 9 | 1 | 10% | 4% |
| 1 | 1 | | 1% | |
| 5 | 1 | 2 | 1% | 8% |
| 10 | 2 | | 2% | |
| 15 | 1 | | 1% | |
| 20 | 2 | 1 | 2% | 4% |
| 25 | 3 | 1 | 3% | 4% |
| 50 | 10 | | 11% | |
| 60 | 1 | | 1% | |
| 70 | 1 | | 1% | |
| 75 | 5 | | 6% | |
| 80 | 4 | 2 | 5% | 8% |
| 85 | 1 | | 1% | |
| 90 | 2 | 5 | 2% | 21% |
| 95 | 2 | 1 | 2% | 4% |
| 100 | 42 | 11 | 48% | 46% |
| **Total** | **87** | **24** | **100%** | **100%** |

**Table 9: Distribution of the percent of contractor work that is safety prequalified in the RMCOEH and ORC surveys**

The answer is a qualified yes.  The qualification comes from our surveys.  In both

surveys the foremost reason hosts give for not safety prequalifying contractors is that the

work to be let does not entail substantial safety risk. This work would provide a very incomplete and close to inadequate benchmark for assessing the effectiveness of safety prequalification on more risky work. However, some work is not safety prequalified because it would overly limit the number of available bidders or is too time consuming. In these non-prequalified emergency/monopoly situations, safety outcomes might be usefully compared with prequalified work to assess the effectiveness of contractor selection. However, to the extent that non-prequalified emergency/monopoly work is uncommon, the sample size for benchmark data will be limited diluting the usefulness of this point of comparison.

A second partial solution to the problem of benchmarking the overall effectiveness of contractor safety prequalification systems is to use before-and-after data from hosts that implement safety selection criteria. This approach presents two not insurmountable problems. First, one must control for other factors that have changed over the time period from before to after the prequalification system was implemented. Often safety prequalification reforms will come within a larger package of host safety management initiatives. It may be difficult to disentangle changes in safety outcomes due to selection and changes in safety outcome due to other factors. Host safety executives in our survey were strongly of the opinion that the single most important factor in determining safety outcomes was the overall host safety culture. If implementation of safety prequalification is a reflection of a change in the host safety culture, this will prove to be an important confounding factor in attempting to benchmark and test the independent effectiveness of the safety prequalification system, itself.

Second, before-and-after comparisons often lack sufficient data on the before stage of the comparison. Hosts get interested in contractor safety prequalification, implement a procedure and begin collecting data. Unfortunately, before the interest in safety prequalification arises, the host may not heretofore collected relevant data on contractor circumstances and safety performance. So often there is an asymmetry in data collection that makes the benchmark before data sparse and less effective.

Despite these problems and qualifications, if the overall effectiveness of safety prequalification systems is significant, then those effects will shine through even imperfect data. The problem will not be determining whether there is a positive effect but rather determining how large that effect is. Also, should the government begin collecting safety outcome data for multiemployer sites broken down by safety prequalified and open sites, then the problems created by private information feedback loops discussed here will be to a large extent resolved. What will not be resolved by that hoped-for government data is an answer to the second main question: what specific procedures within the safety prequalification system work best?

**Detailed Effectiveness.** Assuming now that there is an overall effectiveness of at least some forms of safety prequalification, the question of which systems of contractor selection are more effective arises and turns out to be more tractable. The devil may be in the details, but the details are more easily sorted out because if information feedback loops have been established, the data to answer the question of effectiveness will be there. Most and perhaps even all systems of safety prequalification will collect different measures of past contractor safety performance and various measures, objective and subjective, of current contractor safety capabilities. Many, if not

most, systems of safety prequalification will have varying levels of contractor scrutiny applied differently to different economic conditions and risk exposure. If proper feedback loops have been constructed to measure current safety outcomes, then, in principle, the data are there to assess the relative effectiveness of different approaches to screening contractors.

The problem arises when hosts adopt a uniformity of approach—always emphasizing this measure of past performance, always utilizing that measure of current capacity. Testing requires controlled experiments involving variation in approaches while implementation of a prequalification tends to require a uniformity of approach to contractors similarly situated relative to economic, work-process and safety-risk factors. The solution lies in finding sufficient variation in approach across worksites within hosts or across hosts within systems of host cooperation including third-party service providers in order to set up quasi-controlled experiments. The statistical techniques for "benchmarking" one approach against another under this quasi-controlled environment are well established in both econometric and epidemiological research. The key data needed to make this experiment feasible are measures that handicap prospective work for safety-risk exposure. Such risks are never fully known, particularly in a specific context, but if companies are systematically doing risk assessments of the work contracted out, sufficient data will exist to reasonably weigh denominator data on exposure to risk based on the knowable risks the contractor is undertaking.

Similar to the discussion above regarding sample size, heterogeneity and measuring success, in an analysis of the effectiveness of the details of a system, utilizing variation in approaches from site-to-site, host-to-host, area-council to area-council or

service-provider to service-provider, variation will provide the basis for benchmarking but variation brings with it increased heterogeneity of tasks and risk exposure that themselves will need to be control for through appropriate indicators put into statistical models. Again, increased sample size will make controlling for confounding factors easier. And once again, standard measures of industry, occupation, task, contractor size and economic conditions (e.g. number of bidders for the work, unemployment in the area, age and wage of the contract) will all assist in controlling for variations in conditions that can lead to variations in safety outcomes independent of the safety prequalification process.

Sample size is, among other things, a matter of time. Some adverse safety events are common such as lost workdays. Some are uncommon such as fatalities. And some are rare such as catastrophic events. Through contractor screening, hosts seek to reduce all three negative outcomes. Testing the relative effectiveness of prequalification schemes in controlling lost workdays requires less observational time than controlling for fatalities and a fortiori less time than what is needed to test the effectiveness of alternative schemes in controlling for catastrophic events. The jury is still out on the question of whether controlling less serious outcomes means that more serious outcomes will also be controlled. Thus, while some dimensions of the relative effectiveness of contractor safety prequalification can be tested soon, others may have to await years for statistical results to become persuasive.

## *The Half-Life of Effective Contractor Screening Criteria*

Once effective screening criteria have been tested and widely adopted by hosts, these safety standards establish a quasi-Darwinian competitive selection process that both

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enhances the safety capacity of the contractor community and induces contractor misrepresentation and cheating. At the point when hosts implement contractor safety standards, these criteria will give the safer contractor a competitive advantage in obtaining the host's work. This advantage will stimulate imitation on the part of competing contractors who will adopt the safe practices required in order to compete. This is a virtuous cycle that will upgrade the safety capacity of the entire contractor community. At the outset of this cycle, hosts may find that their costs rise due to a limited number of bidders, but as the contractor community collectively upgrades their safety capabilities, the presence of bidders will be refreshed and host costs will moderate due to renewed competition. Indeed, in competing for host work, contractors will look for the most efficient/least-costly way to implement the new safety standards. Unfortunately, this also creates an incentive for contractors to cheat by misrepresenting their past performance or current safety capabilities. From the foregoing dynamic arise two separate issues regarding the safety criteria adopted by hosts: first, there is a fleeting usefulness of any one safety criterion, and second, there is a need to counter contractor strategies designed to game the system.

**The Quadratic Effectiveness of Safety Criteria.** A quadratic function is like a cannon shot—it rises up to a point and then it falls. The effectiveness of contractor safety selection criteria will follow a quadratic function rising in usefulness for a time and then falling. Initially, new safety criteria will not be widely employed by contractors. In demanding these measures of past safety performance or current safety capacity, hosts are necessarily limiting the number of qualified bidders and raising their own costs. As these innovative safety procedures and better safety outcomes diffuse

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within the contractor community, host costs at bid will fall due to renewed competition. But eventually, as the criterion becomes common, it will no longer serve as a spur to further safety improvements not distinguish the overall safer contractor from the less safe contractor based on the hidden aspect of any uncommon safety criterion. Safety standards that are not widely adopted select not only for the contractor that has that attribute or uses that technique, it also selects among contractors that may have adopted correlated cutting edge safety procedures. New criteria because they are new/uncommon may select for safety conscious contractors. Thus, as new criteria become common, these criteria will no longer serve the hidden purpose of selecting for safety-innovative contractors. So the usefulness of criteria will have a life cycle. In their youth, these criteria may be more costly but they will select for innovative contractors and spur the contractor community towards higher standards. In their maturity, these standards will have reduced the costs of implementing their requirements but ceased to continue goading the contractor community towards. In their dotage, these criteria will no longer be useful in distinguishing better from more dangerous contractors as all will have adopted this by-now common practice.[21]

**The Gaming of Criteria.** Competition not only begets improvement: it stimulates cheating. In nature, due to the competitive pressures of natural selection, sometimes a species will engage in false advertising. The Viceroy butterfly mimics the coloration of the Monarch butterfly in order to fool birds into thinking the Viceroy is as unpalatable as the Monarch. The aforementioned nonpoisonous Scarlet King Snake

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[21] As an example, consider the hard hat. In its day, the hard hat was an innovative safety practice not widely implemented. No doubt, the wide adoption of hard hats reduced injuries and saved lives. Today, even the very unsafe contractor is likely to require hard hats. So what at one time a standard that might have distinguished the progressive contractor from others no longer serves as a distinguishing factor even though hard hats continue to be an effective injury preventative tool.

mimics the coloration of the poisonous Eastern Coral Snake. Both fakes are seeking the advantages of the real thing without undergoing the costs associated with producing toxins. Just as competition in nature can create fakes, so can selective pressure in markets create frauds. For instance, suppose that having a behavioral-based safety program proved to be an effective predictor of contractor safety and was rigorously used as a screening device. Many contractors would thus adopt behavioral-based safety programs. But because these programs have costs, and because a written program can be cheaply obtained, widespread use of this criterion might well lead to widespread contractor misrepresentation of what their actual safety program is. This sets up an arms race between screener and contractor. At the next stage, the screener might more closely scrutinize contractor representations. The contractor might respond by implementing behavior-based safety programs incompletely or ineffectively if that saves on the cost of such implementation. The screener then must dig deeper into contractor implementation raising the cost of screening. Alternatively, let us say lost workday injury rates prove highly predictive of future contractor safety outcomes. As contractors get selected based on this criteria, some contractors will implement safer procedures in order to lower their lost workday injury rates. Others, however, may lower their lost workday rates by under-reporting injuries or misclassifying injuries into light duty. Again, an arms race is established where the host's screener will have to dig deeper to uncover true past injury performance.

Thus, even effective screening criteria will have a half-life. The criterion will go through a natural life cycle of selecting safety conscious innovators, stimulating improvement and then losing its ability to distinguish between safer and less safe

contractors.  The criterion will also have the perverse effect of stimulating fraud and

misrepresentation generating an informational arms race between the host screener and

the fraudulent contractor.  Thus, the cost of verifying the accuracy of whether or not the

criterion has been met will rise over time.  All this means that testing for the effectiveness

of any particular criterion in enhancing contractor safety will be time contingent on when

in the life cycle of the criterion the test is conducted.  Testing for the efficacy of a

particular contractor safety prequalification system and the efficacy of the details of that

system must be an ongoing process reflecting evolving safety technology and procedures,

the natural life cycle of criteria and the informational arms race between screeners and

misrepresenting contractors.

## *Open Source Safety Prequalification Systems*

Enhanced safety has a market value as well as a moral value.  That market value

has the potential to kill the goose trying to get the golden egg.  If a particular host or a

particular service provider develops a better way to screen contractors, that host or

provider has an incentive to try to privatize and capture the benefits of enhanced safety

for themselves.  Secret or proprietorial safety criteria run counter to the broader host

community interest to stimulate overall improvements in contractor safety criteria and

secrecy can limit the diffusion and/or examination of the effectiveness of the proprietorial

criterion.  Testing the effectiveness of safety-based prequalification systems and their

details is best done with the widest scope of variation in approach and the largest samples

possible.  Thus, there are both public good aspects of contractor safety prequalification

systems and economies of scale in testing the efficacy of those systems that beg for those

systems to be open with techniques known and outcomes published.

This issue must confront the fact that both in the UK and in the US, contractor safety prequalification is primarily being developed in the private sector by both for profit and nonprofit firms and within for profit host companies. This privatized approach to contractor safety prequalification has the benefit of innovation stimulated by competition but it brings with it the cost that such innovation may fail to capture the public goods benefits generated by contractor safety prequalification or be able to implement the economies of scale necessary to test and fine tune the details of these systems. Greater public-private partnerships are needed to combine the benefits of competition in innovation with the benefits of economies of scale in testing with the public benefits of better safety. Perhaps one approach might be to establish a quasi-public nonprofit institute into which data on the performance of varying safety prequalification systems can be fed and out of which tests of the effectiveness of alternative criteria can be promulgated.

## *Summary*

Testing the effectiveness of contractor safety prequalification systems and their details is an ongoing process of test-refinement-test-again. The necessary condition for this process of test and refinement is the establishment of feedback loops that knit together the process of safety selection with the safety outcomes of selection. These informational feedback loops need to be widespread in order to obtain sufficient variation in approaches and sufficient samples of outcomes to effectively benchmark safety prequalification against no prequalification and one approach towards prequalification against another. This means these feedback loops have to span worksites, hosts and even third party prequalification providers. The third party prequalification providers

themselves provide an in-place set of institutions for knitting together the experiences of various hosts, but there may be a need for an overarching public or quasi-public agency that collects information across hosts and third-party service providers.

Both outcomes (numerator data) and exposure (denominator data) are needed to assess the effectiveness of prequalification on safety. The exposure data needs to be more than just work hours and/or contractor time on the site. These time measures need to be weighted by the inherent safety risks of the work the contractor is doing. Widespread host risk assessment of the work to be let is precisely the data needed here. In the absence of this more precise data, indicator data on the industry, occupation and tasks of the work let to contractors is a second best approach to weighting time exposure by risk. Outcomes data may need to be reformulated in order to capture the main safety outcomes hosts seek to limit. Hosts seek to limit the risk of serious injuries, fatalities and catastrophic events. Additional measures for serious injuries other than lost workdays and average days away from work may be needed. This would include a frequency of days lost bundled into perhaps 3, 5, 10 and 20+ workday lost cases. Multiple injuries in one event data may be needed to both capture the seriousness of the event and perhaps predict catastrophic events. Combining injury data with property loss data from accidents may be another way of anticipating catastrophic failures. Near-miss data may also be helpful even though it is more subject to underreporting and subjective assessment. In short, testing the effectiveness of safety prequalification systems presupposes a reevaluation of the data used to measure safety. The establishment of informational feedback loops on top of safety prequalification systems provides an opportunity to implement innovative data collection.

Conventional and widely available statistical techniques are available to test the effectiveness of safety prequalification systems, but these tests will always be contingent upon when in the life-cycle of a each criterion in the system the test is conducted. Criteria will have varying cost implications and varying screening effectiveness depending upon whether the criterion is new, mature or old. Criteria will also have varying effectiveness and varying cost depending upon where in the informational arms race between screeners and contractors the test is conducted. In all cases, testing the effectiveness of safety prequalification systems benefits from greater variation in approach and larger samples of events. While across-host cooperation and third-party safety prequalification service providers present two types of in-place institutions that can facilitate data gathering and testing, a public or quasi-public nonprofit may facilitate the economy-wide gathering of safety prequalification data and testing for the efficacy of the technique in general and variations in prequalification standards in particular.

# Chapter 6 Analysis of ORC Large-Sized-Host-Employer Safety Prequalification Survey

In the fall of 2007, health and safety directors of major American corporations were surveyed regarding their contractor safety prequalification practices. On average, these companies employed almost 62,000 workers each with 28 percent of those workers being contract workers. (Table 10) Here we provide an analysis of 25 responses to this survey. Our analyses will cover the following topics:

1. The effects on safety prequalifying of short-term vs. long-term contractor relationships to host employers

2. Safety prequalification practices

3. Safety prequalification constraints on bidding

4. Reasons not to safety prequalify

5. Reasons to safety prequalify

6. Useful predictors of contractor safety based on past practices

7. Safety culture, communication and compensation

8. Specific characteristics of contractors revealed in field audits or managerial inspections

## *Short-term and Long-term Contractor-Host Relationships*

Nineteen of the 25 respondents provided information regarding the tenure of contractors in their facilities. The majority of contractors were on site for less than a year with 43% working for less than six months and 18% working for from 6 months to a year. On the other hand, 17% of the contractors worked on site for between one and two

years while 24% were on site for more than two years.  This pattern and these differences

are important because the process of prequalifying contractors is different for short-term

and long-tenured contractors.  Among other things, the fixed cost of prequalifying a

contractor can be spread over a longer time and probably a larger contract when

prequalifying a long-tenured contractor.  This implication, however, must be qualified by

the requirement to periodically requalify long-tenured contractors.

**Table 10: Descriptive Statistics for Survey responses**

| Variable | Host Employers | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| Total number of host direct-employees | 25 | 61,780 | 78,797 | 2,500 | 300,000 |
| Total number of contract workers on site | 24 | 15,869 | 31,318 | 0 | 150,500 |
| Percent contract workers of total | 24 | 28 | 23 | 0 | 90 |
| Percent contractors working 6 months or less | 19 | 43 | 33 | 5 | 100 |
| Percent contractors working 6 to 12 months | 19 | 18 | 14 | 0 | 50 |
| Percent contractors working 1 to 2 years | 19 | 17 | 12 | 0 | 40 |
| Percent contractors working more than 2 years | 19 | 24 | 19 | 0 | 65 |
| | | | | | |
| Percent contract workers with higher turnover compared to host employees | 25 | 88 | 33 | 0 | 100 |
| Percent contract workers with lower wages compared to host employees | 25 | 68 | 48 | 0 | 100 |
| Average age of host employees | 17 | 39 | 5 | 27 | 50 |
| Average age of contractor employees | 17 | 35 | 7 | 23 | 45 |
| | | | | | |
| Percent of work safety prequalified | 24 | 77 | 36 | 0 | 100 |
| Percent of contractors who do not pass safety prequalification standards | 22 | 15 | 21 | 0 | 95 |
| Average number of safety prequalified contractors on bid list | 21 | 1,415 | 1,704 | 0 | 5,000 |
| Percent of nested or resident contractors | 21 | 30 | 26 | 0 | 90 |
| | | | | | |
| Percent of construction contractors | 22 | 31 | 24 | 4 | 90 |
| Percent of maintenance contractors | 22 | 30 | 19 | 1 | 60 |
| Percent of production contractors | 22 | 22 | 28 | 0 | 93 |
| Percent of service contractors | 22 | 13 | 12 | 0 | 47 |
| Percent of other kinds of contractors | 22 | 5 | 17 | 0 | 75 |

The data in Table 10 are averages by host employer.  Because the host employers are of different sizes and the number of contract workers varies by host employer, the averages in Table 10 can differ if they are weighted by the number of contract workers each host employs.  While we will see that this is the case in some instances, it is not the case in terms of the length of contractor tenure.  Figure 14 compares the length of contractor tenure Unweighted and weighted by the number of contract workers. Weighting by the number of contract workers yields a slightly higher percentage of the contract work being done by contractors on site more than two years with the amount of contract work lasting less than 6 months remaining the same and somewhat less work being done by contractors in the 6 months to two year range.  The overall point is this: contract work divides into short-term and long-tem relationships.  This will influence the needs and procedures involved in safety prequalification.

# 40%+ Contractors Work for Less than 6 Months—25% Work for 2+ Years



Unweighted

Weighted by number of contract employees
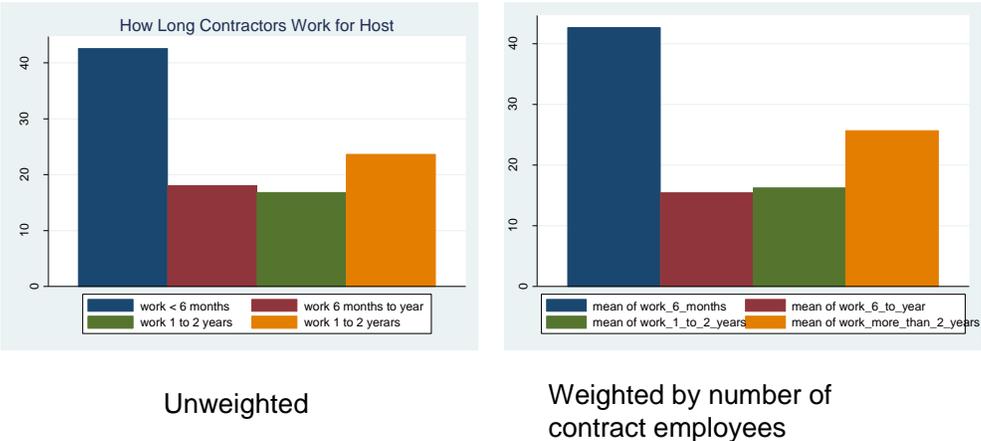
**Figure 14: Contractor tenure with host employer unweighted and weighted by number of contract workers**

**Host and Contractor Worker Characteristics.** Contract workers are paid less 68% of the time and change jobs more 88% of the time compared to host direct-employees. From the survey, we do not know how much less contract workers are paid, nor do we know how much more contract workers experience labor turnover. Because of the wide range of host employers and contractor activities in this survey, there no doubt is considerable variation in the magnitude of the difference in wages and turnover encompassed in this survey. Nonetheless, from an economic standpoint, lower wages of any significant magnitude and higher labor-turnover go hand-in-hand. Contract-labor turnover is important because it raises the cost of safety-training workers as you

continually have more inexperienced workers entering, and it reduces the amount of

accumulated relevant work experience that is needed for safe working habits.

Our survey indicates that, on average, contract workers are 35 years old compared

to host direct-employees averaging 39 years of age. The minimum average age for

contract workers by host was 23 compared to a minimum average age of 27 for host

direct-employees. Youth, in itself, is a risk factor for workplace injuries.
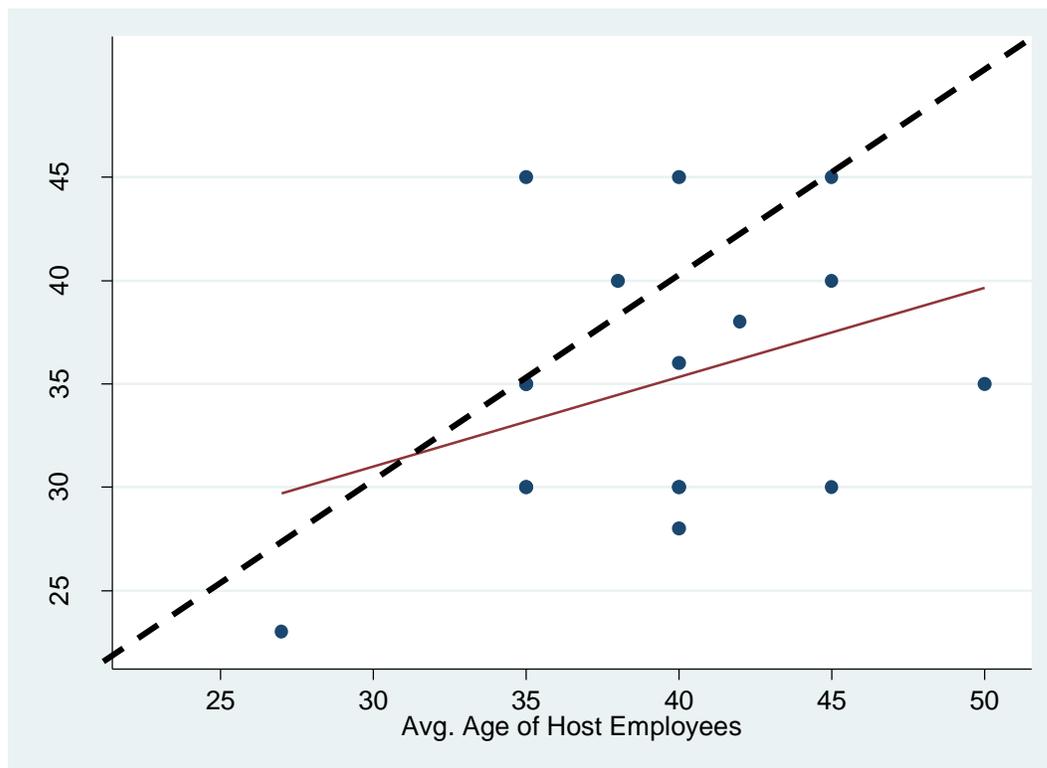


**Figure 15: Age of contract workers in relation to age of host direct-employees**

Figure 15 shows the age of contract employees in relation to the age of host

direct-employees. The solid line is a regression line showing that as the age of host

workers rises, the age of contract workers rises as well. The dashed line in Figure 15 is a

45 degree line. If the regression line had landed on the 45 degree line, that would have

indicated that the age of host workers and contract workers were the same host-by-host

and that as host workers' ages rose, contract workers' ages would rise in lock-step. The fact that in most cases the observations fall below the dashed line indicates that in most cases contract workers are younger than host direct-employees and the fact that the regression line rises a gentler slope than the dashed line indicates that contract worker age rises with the age of host workers but rises more slowly. This is important because age is a risk factor in workplace accidents. These data indicate that contract workers are likely to be at greater safety risk. Furthermore on the assumption that increases in host direct-employee age is a reflection of rising skill and experience demands, some of which may be tied to safety risk, contactor respond less to that safety risk through increasing the age (and presumably experience) of their workforce. Taken together, the lower wages, higher turnover and younger age of contract workers suggest that they pose a distinct challenge for safety management. These data support implementing safety prequalification practices.

**Safety Prequalification Practices**. Among host employer survey respondents, 77% of their contracted work is safety prequalified. Of the work that is prequalified, 15% of the contractors fail to become prequalified. Weighting these results by the number of contract workers, the amount of work prequalified rises to 82% and the percent of contractors who fail to safety prequalify rises to 22%. Failure to prequalify is a double-edged sword. On the one hand, if all contractors submitting to prequalifying standards expect to pass, then prequalification neither separates the safe from the unsafe contractor nor does it set a standard of safety that contractors will feel obliged to meet. On the other hand, high levels of contractor failure rates can restrict the pool of available bidders

increasing the cost of contracting out work.  A 15% (unweighted) to 22% (weighted)

failure rate suggests a compromise between these competing objectives.  More can be

learned about the determinants of safety prequalification failure from the linear

regression model reported in Equation 10:

**Equation 10: Percent contractors failing safety prequal as a function of contract worker wages, percent contract workers, percent short term contractors and host employer use of prequal services**

## Linear regression

| | Number of host responses | **19** |
|---|---|---|
| | F( 4,   14) | 6.79 |
| | Prob > F | 0.003 |
| | R-squared | 0.8024 |

**Dependent variable=percent contractors failing to safety prequalify**

| | Coefficient | Robust Std. Err. | t | P>t | 95% Confidence Interval | |
|---|---|---|---|---|---|---|
| Lower wages for contract workers compared to host workers | 15.09 | 6.10 | 2.47 | 0.03 | 2.01 | 28.17 |
| Percent contract workers of all workers | 0.70 | 0.15 | 4.64 | 0.00 | 0.38 | 1.02 |
| Percent contractors on site less than 6 months | -0.20 | 0.07 | -2.96 | 0.01 | -0.34 | -0.05 |
| Host does not share info or use a prequal service | 20.80 | 7.98 | 2.61 | 0.02 | 3.68 | 37.93 |
| constant | -17.07 | 9.56 | -1.78 | 0.10 | -37.58 | 3.45 |

| Variable | Mean | Std.Dev. | Min | Max |
|---|---|---|---|---|
| Percent contractors failing to safety prequalify | 17 | 22 | 0 | 95 |
| Lower wages for contract workers compared to host workers | 0.68 | 0.48 | 0 | 1 |
| Percent contract workers of all workers | 25 | 23 | 0 | 90 |
| Percent contractors on site less than 6 months | 43 | 33 | 5 | 100 |
| Host does not share info or use a prequal service | 0.68 | 0.48 | 0 | 1 |

Equation 10  predicts the percent of contractors failing safety prequalification

based on a) whether or not contract workers are paid less than the host's direct-

employees, b) the percent of all site workers employed by contract workers, c) the

percent of contractors on-site for less than six months, and d) whether or not the host

either shares information about contractors with other host employers and/or the host uses

a safety prequalifying service company.  The hypotheses behind these factors are as

follows: a) if the contract workers are paid less than the host employees, then it may be

more difficult to bring those workers up to the host's safety standards leading to a greater safety prequal failure rate; b) if contract workers are a greater percentage of all the host's work, then it is more likely that at least some contractors will be tackling challenging safety tasks which would imply higher prequal standards and greater failure rates; c) a higher percentage of short-term contractors could go either way: many short-term contractors might mean many contractors who are not familiar with the host's work site and safety procedures leading to a higher prequal failure rate, or many short-term contractors might mean limited safety prequal testing due to the cost of prequalifying many contractors for a short period of time; d) not sharing information about contractors with other hosts and/or not using a prequalifying service company limits the host's leverage on contractor behavior. To offset this limited leverage, hosts may increase their safety prequalification failure rate to send contractors a message regarding the importance of meeting safety standards.[22]

Nineteen host employers provided sufficient data in the survey to be included in the Equation 10 model. The table below the regression results shows that 17% of all contractors attempting to safety prequalify for these 19 host companies fail. Sixty-eight percent of the hosts (13 hosts) have contract workers, on average, earning less than host direct-employees. Twenty-five percent of the work is done by contract workers and 43% of the contractors are on site for less than six months.

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[22] Hosts that share information about contractor safety experience and capabilities send a stronger message to those contractors about their safety compliance behavior. Meeting one host's standards may mean qualifying for multiple hosts' work creating a multiple incentive to enhance the contractor's safety capabilities. Similarly, hosts working through safety prequalifying service companies leverage their pressure on contractors to come up to safety standards. Hosts that do neither may counter the leverage effect by having a higher failure rate sending a strong message to contractors about the seriousness of the host's safety requirements. In general, there is probably a tradeoff between higher failure rates and leveraged standards via multiple cooperating hosts in sending a message to contractors about safety standards.

Examining the regression results, themselves (in the upper panel above), the model fits the data well (an R-squared of .80 indicates that 80% of total variation in contractor safety prequal failure rates is explained by the model). All of the included variables are statistically significant (t statistics greater than 1.96). And the direction of the effects are understandable and as expected. If the contract workers receive, on average, lower wages than the host workers, then the failure rate increases by 15 percentage points. If the percent of all workers who are contractor workers increases by 10 percent, then the failure rate increases by 7 percentage points. If the host does not share safety information about contractors with other host employers and/or the host does not use a safety prequalification service company, the contractor failure rate increases by 20 percentage points. Finally, if contractors working onsite for less than six months as a percent of all contractors increases by 10 percent, the failure rate actually declines—by 2%. We do not interpret this last result as an indication that short-term contractors are safer and therefore have an easier time passing safety standards. In all probability, long-term contractors have come to learn the host's safety procedures and are probably, on average, safer contractors in the host's environment. We think the result we find indicates that hosts, on average, have laxer standards for short term contractors due to the cost of prequalifying many contractors for a short period of time

We can test this last speculation by reformulating Equation 1 dividing hosts into those who do use prequalifying services and/or share information about contractors with other hosts compared to those hosts who do not share information both in relationship to the percentage of all contractors who are on the job for less than six months. If indeed, hosts are relaxing their standards due to the cost of prequalifying short-term contractors,

this effect should be strongest among hosts who do not share information or use a prequalifying service that effectively pools information about contractors. Where information is shared or pooled, the cost of prequalifying short term contractors should be less and therefore the need to relax standards to save on prequalification costs should be less.

In Equation 11 we modify Equation 10 by bifurcating the variable "percent contractors on site less than 6 months" into two variables—one where hosts share information and one for hosts that do not. In the data, there are 6 hosts who share information or use a prequalification service provider with an average of 34% of their contractors on site for less than six months. In contrast, there are 13 hosts who do not share information about contractors or use a prequalifying service company and 46% of their contractors are on site for less than 6 months. The hypothesis is that discounting standards for short term contractors is not as severe among sharing contractors and therefore the failure rate will not drop or not drop as far when the percent of short term contractors rises in the case of sharing contractors.

**Equation 11: Percent contractors failing safety prequal as a function of contract worker wages, percent contract workers, host employer use of prequal services and percent short term contractors divided by hosts who share information about contractors and hosts who do not**

## Linear regression

| | | |
|---|---|---|
| Number of host responses | **19** |
| F( 4, 14) | 5.4 |
| Prob > F | 0.0066 |
| R-squared | 0.8032 |

**Dependent variable=percent contractors failing to safety prequalify**

| | Coefficient | Robust Std. Err. | t | P>t | 95% Confidence Interval | |
|---|---|---|---|---|---|---|
| Lower wages for contract workers compared to host workers | 15.48 | 5.44 | 2.84 | 0.01 | 3.71 | 27.24 |
| Percent contract workers of all workers | 0.69 | 0.16 | 4.32 | 0.00 | 0.35 | 1.04 |
| Host does not share info or use a prequal service | 23.10 | 11.70 | 1.97 | 0.07 | -2.17 | 48.38 |
| Percent contractors on site less than 6 months and share information | -0.14 | 0.33 | -0.44 | 0.67 | -0.84 | 0.56 |
| Percent contractors on site less than 6 months and DO NOT share information | -0.21 | 0.07 | -2.94 | 0.01 | -0.36 | -0.05 |
| constant | -19.10 | 10.70 | -1.78 | 0.10 | -42.23 | 4.02 |

The results in Equation 11 are quite similar to the results in Equation 10 for the unmodified variables—lower wages for contract workers, percent contract workers and host does not use a prequalifying service or share information with other hosts. When breaking down short term contractors by sharing and non-sharing hosts, the effect on the failure rate of an increased percentage of short-term contractors is negative but not statistically significantly different from zero (i.e. no effect at all). In contrast, the effect of more short-term contractors on the prequalification rate of non-sharing contractors is more negative and statistically significantly different from zero.[23] Thus, it is the non-sharing hosts that relax their failure rates (and by implication their safety standards) in the face of increasing percentages of short-term contractors. This is consistent with the

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[23] The critical t-value in determining statistical significance at the 5% chance of being wrong is 1.96 or greater. An inspection of Equation 11 shows that in the case of sharing hosts, this value is well below statistical significance while for non-sharing hosts it is well above statistical significance. Another way of seeing this is noticing the 95% confidence intervals for the two variables. In the case of sharing hosts, the true effect of increased percentages of short-term contractors on failure rates ranges from a +.56 to a -.84. This range is too wide to confidently think there is any effect at all. In contrast the 95% confidence interval for non sharing hosts is tighter and always negative giving confidence that the true relationship is negative and well estimated.

hypothesis that sharing information and/or using safety prequalification service companies allows hosts to maintain safety standards even as the cost of prequalification rises with increased use of short-term, high-turnover contractors. The economies of scale associated with sharing information and/or using a service company appear to offset the cost of high-contractor-turnover safety prequalification.

## *Safety Prequalification Constraints on Bidding*

Host health and safety executives were asked "Compared to open bidding by contractors, does prequalifying contractors based on safety usually make getting enough bids on a project a) substantially more difficult, b) somewhat more difficult, c) slightly more difficult, d) about the same as open bidding. Their responses are summarized in Figure 16.

**Effect of Safety Prequalifying on Getting Enough Bids**
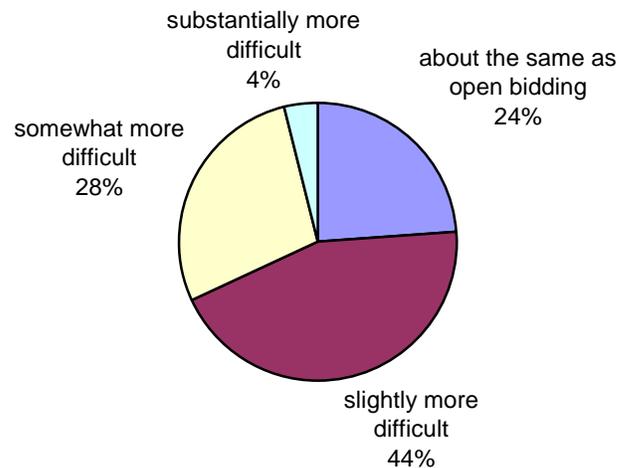


**Figure 16: Effect of safety prequalifying on the difficulty of obtaining competitive bids**

Based on this subjective scale, most host health and safety executives do not

perceive safety prequalification as a substantial barrier to obtaining a competitive bid.

Twenty-four percent saw no difference and an additional 44% thought it was only

slightly more difficult to obtain a sufficient number of bidders under safety

prequalification compared to the open market.  Only one host (4%) thought safety

prequalification made it substantially more difficult.  We can drill down into these

responses by asking the question, under what circumstances do these respondents feel

safety prequalification creates increasing difficulty in obtaining bidder-numbers similar

to open market bidding.

**Equation 12: Ordered logistic regression predicting greater difficulty in obtaining enough bidders based on on-site contractor turnover and construction and maintenance activity**

# Ordered logistic regression

| | | | | | Number of obs = | 19 |
|---|---|---|---|---|---|---|
| | | | | | LR chi2(4) = | 6.75 |
| | | | | | Prob > chi2 = | 0.1496 |
| | | | | | Pseudo R2 = | 0.1526 |

**Dependent variable=getting bids harder**

| | Odds Ratio | Std. Err. | z | P>z | 95% Confidence Interval | |
|---|---|---|---|---|---|---|
| Percent contractors on site less than 6 months | 1.08 | 0.04 | 2.20 | 0.03 | 1.01 | 1.16 |
| Percent contractors on site 6 months to a year | 1.13 | 0.07 | 2.10 | 0.04 | 1.01 | 1.27 |
| Construction work most common | 22.19 | 37.51 | 1.83 | 0.07 | 0.81 | 610 |
| Maintenance work most common | 29.33 | 61.82 | 1.60 | 0.11 | 0.47 | 1825 |
| /cut1 | 5.20 | 3.07 | | | -0.82 | 11.22 |
| /cut2 | 8.00 | 3.38 | | | 1.37 | 14.63 |
| /cut3 | 11.14 | 4.03 | | | 3.25 | 19.03 |

| Variable | Mean | Std.Dev. | Min | Max |
|---|---|---|---|---|
| **Getting bids harder** | 2 | 1 | 1 | 4 |
| **Percent contractors on site less than 6 months** | 43 | 33 | 5 | 100 |
| **Percent contractors on site 6 months to a year** | 18 | 14 | 0 | 50 |
| **Construction work most common** | 0.32 | 0.48 | 0 | 1 |
| **Maintenance work most common** | 0.26 | 0.45 | 0 | 1 |

Equation 12 uses an ordered logistic regression model (the appropriate technique

when your dependent variable is a ranking such as same, slightly more, somewhat more

and substantially more) to predict the difficulty in obtaining a competitive number of bids based on the percent contractors on site less than six months compared to longer than a year, between six months and a year compared to longer than a year, and whether or not the work is construction work or maintenance work compared to all other kinds of contract work.[24]  In this regression, the mean response was 2, "Getting bids under prequalification is slightly harder than open market bidding."  Forty-three percent of the contractors were on-site less than six months and 18% were on-site between six months and a year (with the remaining 39% being on-site longer than one year).  Thirty-two percent of the work was construction and 26% was maintenance with the remaining 42% being other kinds of contracted work.

An ordered logistic regression predicts the odds that a unit change in an independent variable will raise (or lower) the odds that you will jump in the ranks of (in this case) the difficulty in obtaining a competitive number of bids.  When the odds ratio is equal to "1.00" there is no effect.  But when the odds ratio is greater than 1.00 then with a unit increase in the independent variable, the odds of rising in the ranks is greater.  On the other hand, when the odds ratio is less than one, a unit change in an independent variable lowers the odds of rising in the ranks (raising the odds of falling in the ranks).  All of the estimated odds ratios are greater than 1.00 in Equation 3, and all but maintenance work are statistically significantly greater than zero.[25]  Equation 12 says that as hosts employ more short term contractors compared to contractors who would be on site longer than

---

[24] Respondents were asked to indicate what the most common contracted work was.  When they responded construction or maintenance, we coded these as the work being done in Equation 3 above.

[25] Results in Equation 12 must be taken with some caution.  Even though three of the four variables are statistically significant, the LR (likelihood ratio chi-square test for the overall model) is only marginally significant at 15%.  This appears due to the limited number of observations upon which the model is tested. ON the whole, it is our judgment that the model provides useful results.

one year, the odds of finding it more difficult to obtain a sufficient number of bidders

rises. Controlling for the length of time contractors are on site, it is more difficult to

obtain a competitive number of bids for construction work compared to other non-

maintenance work. It may also be more difficult to obtain a sufficient number of bids in

the case of maintenance, but this estimate is only marginally statistically significant.

The relative size of these odds ratios are due to the units in which the variables are

measured. For the construction variable, the unit is zero-one with one indicating that the

most common work given to contractors is construction work. The odds ratio says that

compared to other non-maintenance work, construction work is 22 times more likely to

be more difficult in obtaining a sufficient number of bidders. For the contractor-on-site

variables the unit is one percentage point. So a one percentage point increase in the

percent of short-term contractors raises the odds of jumping in the ranks of difficulty in

obtaining enough bids by around 1.1. So it is (about) 1.1 times more likely to be more

difficult getting enough bidders for each percentage point increase in the percent of short-

term contractors.

What Equation 12 is telling us is that getting enough bidders is more difficult if

the contract work is short term and/or if the contract work is construction work and

(possibly) maintenance work. Thus, these are the areas where safety prequalification—to

the extent it makes getting enough bidders—is more problematic. Long term work is less

of a problem. Whether maintenance work is a problem is uncertain.

## *Reasons not to Safety Prequalify Contractors*

When asked to rank various reasons why a host employer might not safety

prequalify contractors, the main reason given (14 of 20 responses) was that some work

poses little or no safety risks. However, in considering work that does pose safety

concerns, in half the cases (10 out of 20) respondents indicated that they might not safety

prequalify contractors if it restricted the number of available bidders. Lower ranked

reasons not to prequalify contractors included the time and expense of prequalification

and the potential exposure to legal liability.

In Equation 13 we model factors determining why a host employer would not

prequalify contractors because prequalification would limit the number of contractors

bidding on a project. Here we employ a binomial logistic regression (a technique adapted

to explaining yes-no responses). The dependent variable is yes—the most important

reason for not prequalifying contractors on jobs where safety is at risk is the possibility

that it would restrict the number of bidding contractors or otherwise no. This is a one-

zero dependent variable.

**Equation 13: Binomial logistic regression predicting reason to not safety prequalify is prequal would restrict the number of bidders (weighted by the number of host and contractor workers)**

# Logistic regression

|  |  |
|---|---|
| Number of hosts | 20 |
| Wald chi2(3) | 9.53 |
| Probability of Chi2 | 0.023 |
| Pseudo R2= | 0.71 |

| Reduces bidders is reason not to prequal = 1 otherwise 0 | Odds Ratio | Robust Std.Error | z | P>z | 95% Confidence Interval | |
|---|---|---|---|---|---|---|
| Percent contract workers of all workers | 1.73 | 0.33 | 2.87 | 0.00 | 1.19 | 2.52 |
| Number of contractors on bid list (in 100s) | 0.59 | 0.10 | -3.00 | 0.00 | 0.42 | 0.83 |
| Host does not share info or use a prequal service | 78 | 177 | 1.93 | 0.05 | 0.94 | 6523 |

| Variable | Mean | Std.Dev. | Min | Max |
|---|---|---|---|---|
| Reduces bidders=reason not to prequal | 0.27 | 0.46 | 0.00 | 1.00 |
| Percent contract workers of all workers | 26 | 25 | 0 | 90 |
| Number of contractors on bid list(in 100s) | 15 | 20 | 0 | 50 |
| Host does not share info or use a prequal service | 0.68 | 0.48 | 0.00 | 1.00 |

In this binomial logistic regression, the responses of hosts are weighted by the size of the host employer measured by adding together the host's employees and the contractor's employees on-site. In this weighted sample, 36% of all workers are contract workers; there are on average 1500 safety-prequalified contractors on the host's bid list and 68% of the hosts do not share information regarding the safety of their contractors not do they use a safety prequalifying service company. This model fits the data well and all variables are statistically significant at the 10% level and all except host-sharing-of-information are significant at the 1% level. With each percentage-point increase in the percent contract workers of all workers, the host is 1.73 times more likely to say the most important reason not to safety prequalify contractors is because it limits the number of needed bidders. In contrast, with each 100 contractor increase in the number of safety-prequalified contractors on the company bid list, the host employer is only 59% as likely to state that the reason not to safety qualify is because it restricts the number of bidders. Most dramatically, if the host does not share information about the safety of its contractors with other host employers and the host also does not use a safety prequalifying service, then the host is 78 times more likely to state that when contractors are not safety prequalified, the restriction of the bidding process is the reason. Thus, long safety-prequalified bid lists and the sharing-service-company approaches can substitute for each other.

## Reasons to Safety Prequalify Contractors

When asked to rank the most important reason to safety prequalify contractors, the majority of host employers said it was "to align the contractor's expectations and safety culture with our own company's work and safety culture." The majority of those

who did not list this as their top reason listed this as their second reason.  The second most common reason for safety prequalifying was "To align the contractor's capabilities with the specific inherent safety risks of the work they will be doing."  This was tied for second among most important reasons and the most common second reason for prequalifying contractors.  (See Figure 17 below.)   In short, most hosts offered aligning expectations as their first reason to prequalify contractors and aligning capabilities as their second most important reason.  Most other contractors simply reversed the order between these two reasons.  Other competing reasons—safety prequalifying also selects for better quality work, safety prequalifying helps meet OSHA requirements and safety prequalifying helps forestall catastrophic events, all were less important than these two aligning expectations and capabilities reasons for safety prequalifying.

# 17 of 23 Hosts Ranked Alignment of Capabilities & Expectations as Highest Ranked Reason to Safety Prequalify
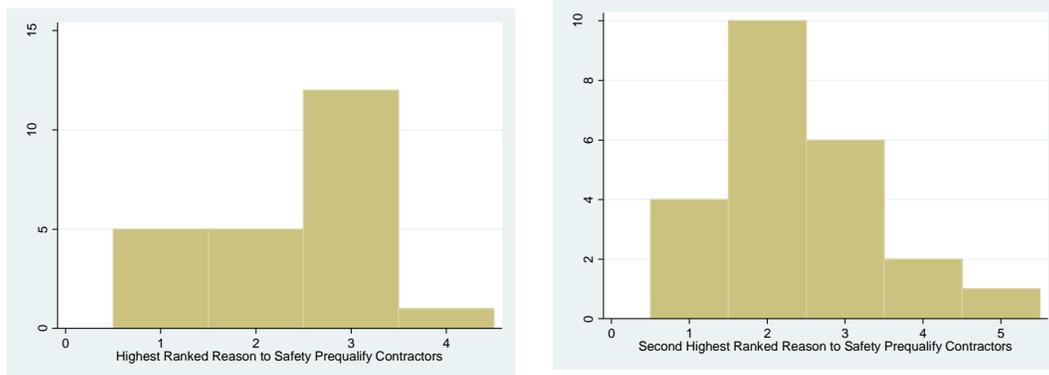


1)  Safety prequalification selects for better overall contractor's so it is an indirect way of getting higher quality work delivered on time
2)  To align the contractor's capabilities with the specific inherent safety risks of the work they will be doing
3)  To align the contractor's expectations and safety culture with our own company's work and safety culture
4)  To meet OSHA and/or EPA regulatory requirements
5)  To safeguard our company against catastrophic events

**Figure 17: Top two reasons for safety prequalifying contractors**

Once alignment of expectations and capabilities were accomplished, the next most important reason to prequalify contractors was overwhelmingly: "Safety prequalification selects for better overall contractors—so it is an indirect way of getting higher quality work delivered on time."
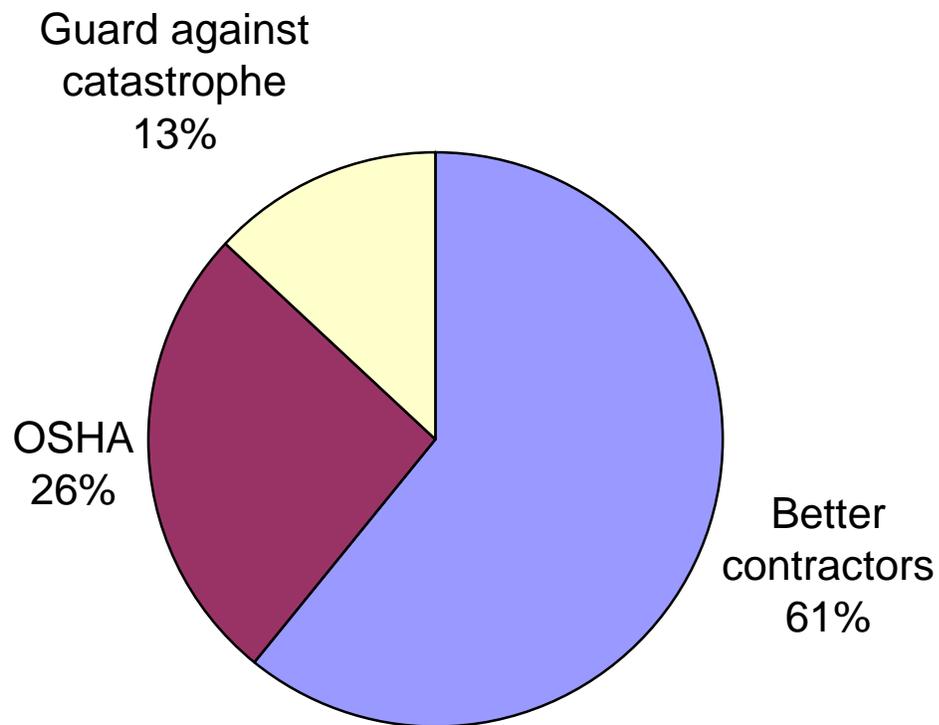
**Figure 18: Once aligning expectations and capabilities is accounted for, hosts believe the next most important reason to safety prequalify is the indirect benefit of obtaining better contractors**

- Safety prequalification selects for better overall contractors, so it is an indirect way of getting higher quality work delivered on time.
- To meet OSHA and/or EPA regulatory requirements.
- To safeguard our company against catastrophic events.

So the general philosophy under-girding safety prequalification, in general, may be

summarized as follows:

> Contractor safety prequalification is instituted primarily to align the contractor's expectations and safety culture with the host employer's work and safety culture. However, almost equally important, safety prequalification is implemented to align the selected contractor's capabilities with the specific inherent safety risks of the work they will be doing. Additionally, but less centrally, safety prequalification has the additional benefit of selecting for a better set of overall contractors providing an indirect means of getting higher quality work delivered in a timely manner. OSHA and EPA regulations are important as is guarding against catastrophic events, but these factors are not at the center of why host employers safety prequalify contractors.

## Predicting Contractor Safety Performance Based on Past Performance

In giving stock market advice, it is conventional to provide the caveat that past

performance does not guarantee future performance. Nonetheless, stock analysts pour

over charts of past performance. The past is not all we have to gauge the safety prospects

of contractors, but it is still a major source of information and concern. Interestingly,

40% of host employers think that the number of past contractor fatalities is the most

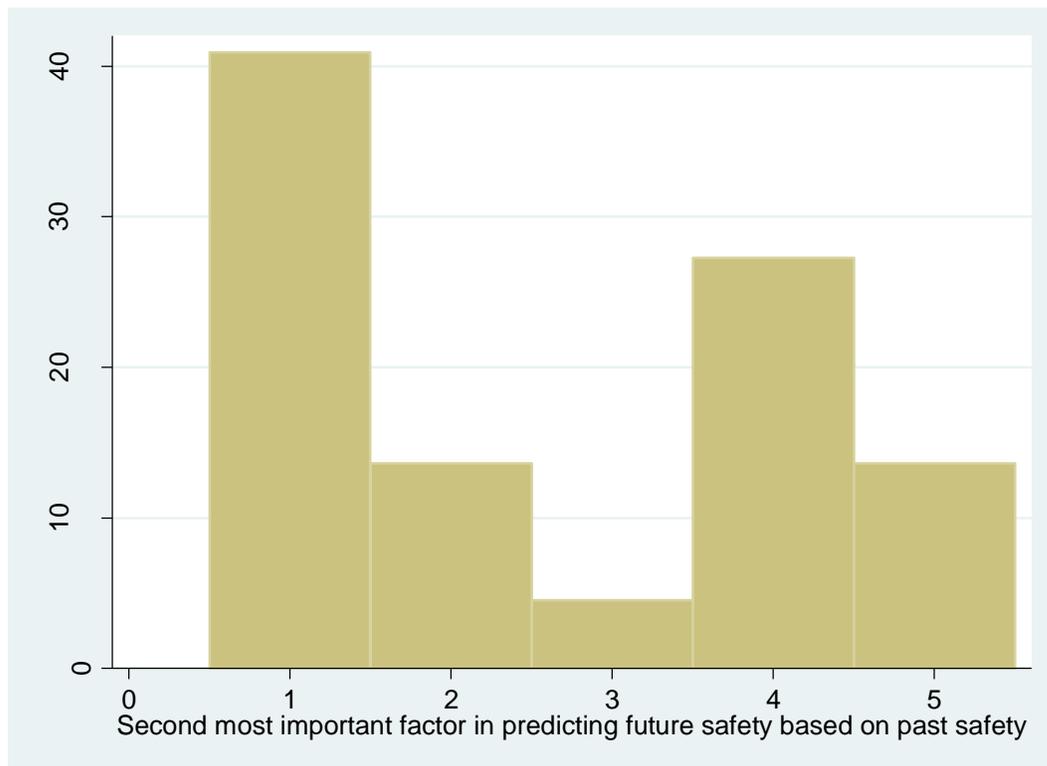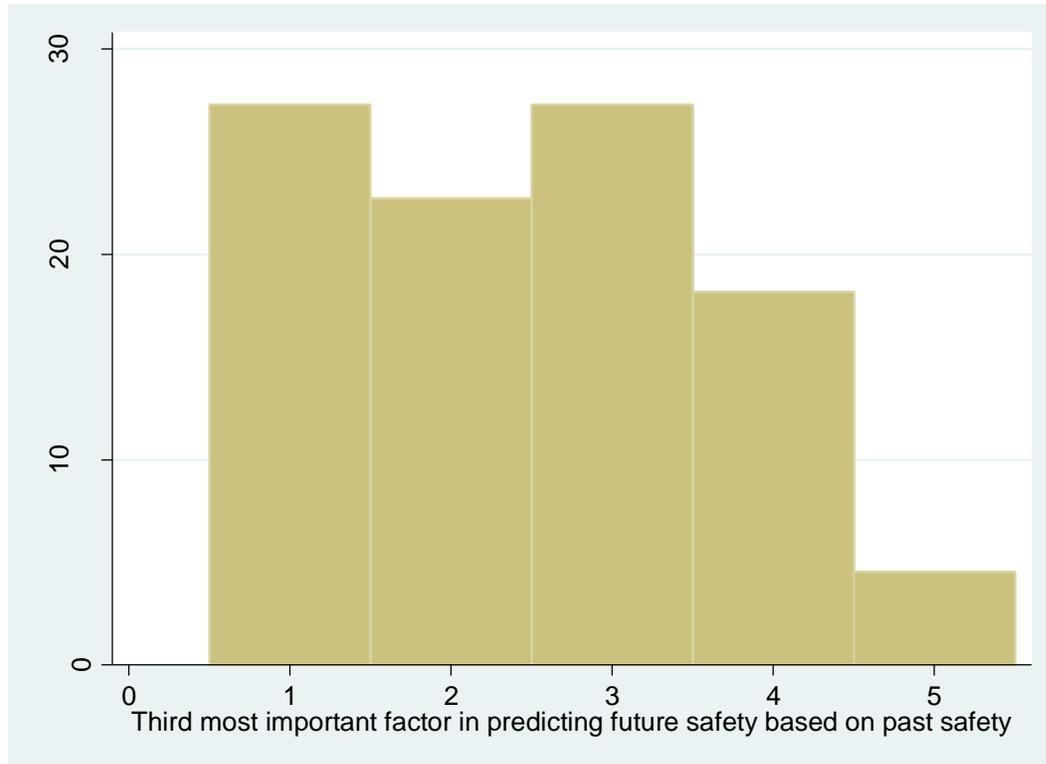important past indicator of future contractor safety performance.
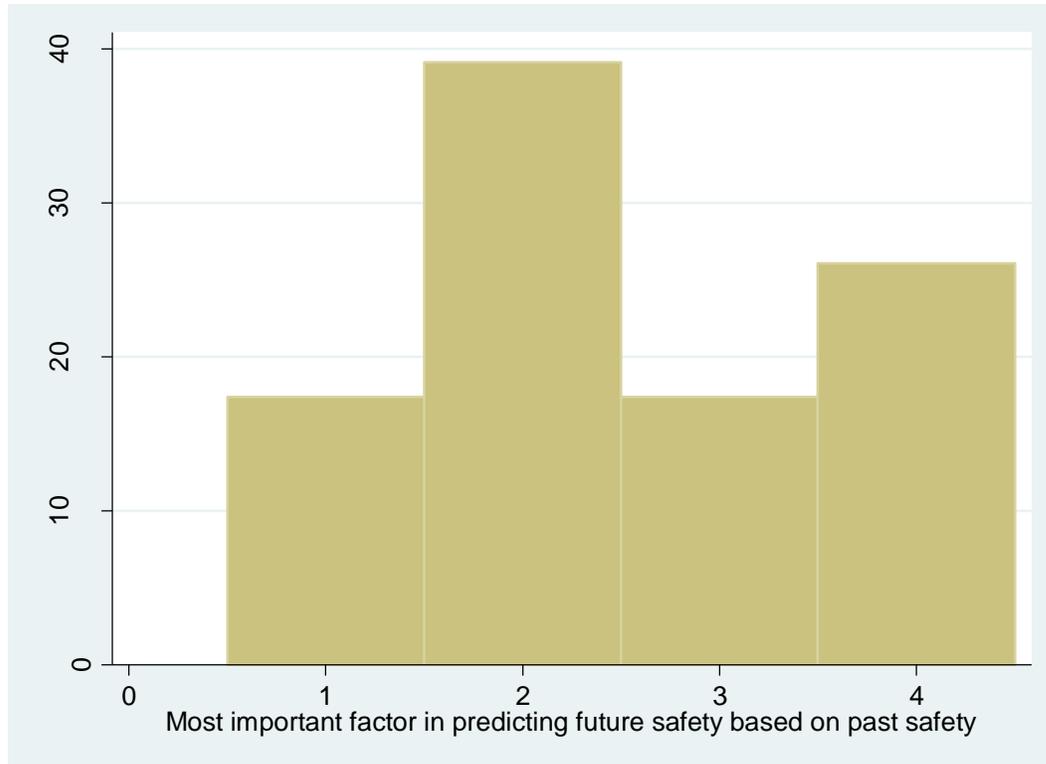
**Figure 19: The most important predictor of future contractor safety based on past contractor safety**

1. Lost workday injury rate
2. Number of fatalities
3. Workers compensation experience modification rate
4. Other

We say this is interesting, but perhaps we should say that it is surprising. Of the various types of poor safety outcomes—fatalities, injuries of various types, near misses, etc.—fatalities are rare events. A dangerous contractor may never have had a fatality and a safe contractor may have been unlucky. Nonetheless, fatalities have two attributes that are key in making them the single most important past indicator of future safety performance. First, of all past poor safety outcomes, fatalities are the least subject to measurement error. Injuries can go unreported or misreported. Near misses can be hard to define, report or even understand what actually occurred. Worker compensation

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experience modification rates are subject to potential manipulation through the under-

reporting of injuries and/or the misclassification of workers. Workplace fatalities may be

the least under-reported poor safety outcome, and because all poor safety outcomes are at

least to some extent the result of bad luck, the number of past fatalities is a red-flag

warning sign that the contractor under consideration should be looked at more closely.

The second most important past indicator according to 40% of the respondents is

past lost workday injury rates. (See Figure 20.)



**Figure 20: Second most important predictor of future contractor safety based on past contractor safety**

1. Lost workday injury rate
2. Number of OSHA citations and value of fines
3. Number of fatalities
4. Workers compensation experience modification rate
5. Other

In Figure 20, the second most important past-performance factor in predicting future contractor safety is dominated by past lost workday injury rates followed by worker compensation experience modification rates.  OSHA fines are less important while fatalities are not an important second reason because they were such an important first predictor.  While past injury rates have significant under-reporting issues, they are nonetheless the meat-and-potatoes of past safety performance simply because injuries are the most common and most visible outcome of past poor safety performance.  Lost workday injury rates provide some measure of severity so that the wide range of seriousness of injuries can be broken out from minor injuries based on whether workdays were lost.  Still, this creates a problem because one form of manipulating the data is moving an injury off the lost workday column by creating light duty work, even make-work in order to reduce the contractor's reported lost workday injury rate.  To this point, the primary reason contractors might do that is to reduce worker comp insurance rates.

In one sense, in Figure 20, you could stack the lost workday column and the worker comp column (columns 1 and 4) on top of each other because for the most part they reflect the same thing—past reported injuries.  After fatalities, host employers essentially believe that various measures of past injuries are the second most important indicator or future contractor safety.  Probably these measures are relegated to a second order of importance due to serious issues of under-reporting.

**Figure 21: Third most important predictor of future contractor safety based on past contractor**

**safety**

> 1. Lost workday injury rate
> 2. Number of OSHA citations and value of fines
> 3. Number of fatalities
> 4. Workers compensation experience modification rate
> 5. Other

In the survey, respondents were asked to rank from 1 to 5, from most to least important past predictors of safety outcomes. The third most important predictor (Figure 21) is in the middle between most and least important and the middle is muddled. No one factor stands out over the others. This is in fact reassuring. This is an inflection point between weighing the most important predictors and the less important predictors.
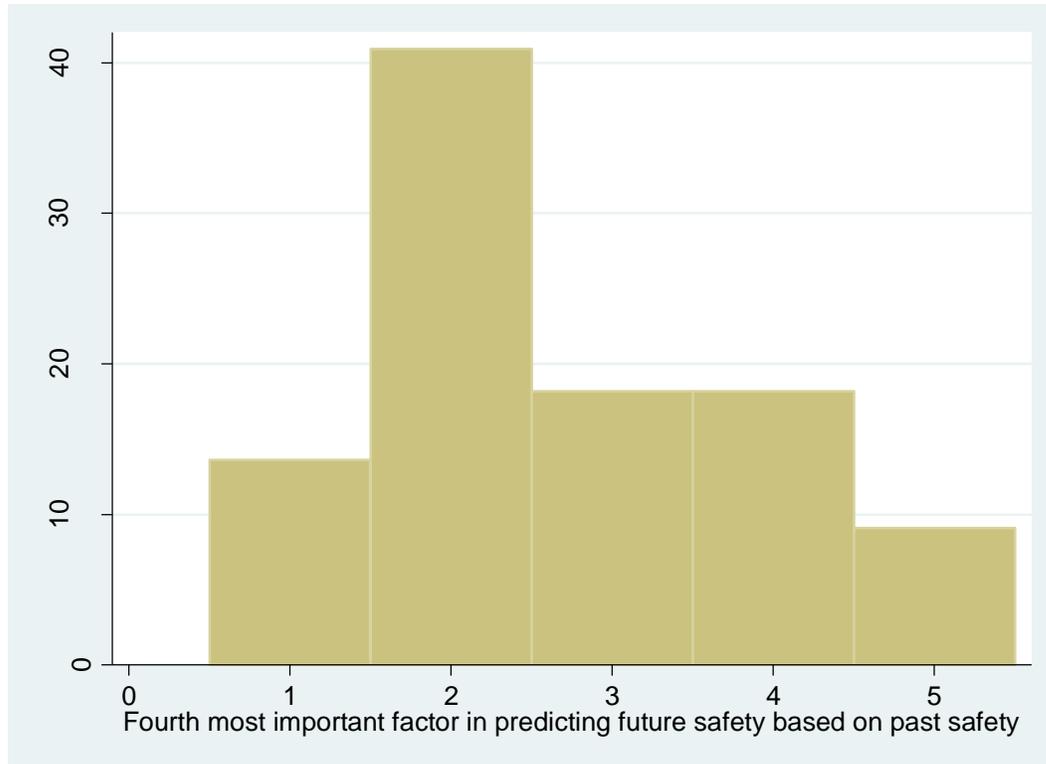
**Figure 22: Fourth most important predictor of future contractor safety based on past contractor safety**

> 2. Lost workday injury rate
> 3. Number of OSHA citations and value of fines
> 4. Number of fatalities
> 5. Workers compensation experience modification rate
> 6. Other

In Figure 22 we see that the number of OSHA citations and the value of fines dominates the fourth most important predictor of future safety outcomes based on past performance. This means that respondents have doubts regarding this predictor compared to previous, higher ranked predictors. The primary reason for these doubts may well be that OSHA enforcement is spotty and unpredictable. This adds an additional source of uncertainty over-and-above under-reporting issues on the part of contractors.

When you conceptually multiply the uncertainties of under-reporting to the vagaries of oversight, the noise in the data regarding past safety performance is becoming loud making the data less reliable. We omit the fifth most important (i.e. the least important) predictor from analysis simply because it was just the grab-bag of whatever was left over having ranked the first four. However, we should note that a small minority of host employers felt that fatalities were the least important predictor of past performance. This reflects the other side of the coin in the case of past fatalities—while less subject to under-reporting, fatalities are nonetheless a relatively rare event and thus more subject to random bad luck. So in some sense, in looking at the past to predict the future, hosts are faced with a dilemma: in using past fatality rates, the host must look through the noise of random bad luck in order to separate out the unsafe from the unlucky; in using past injury rates or work comp rates, the host must look through the noise of intentional under-reporting on the part of some (but not all) in order to separate out the safe from the unscrupulous.

## *Predicting Contractor Safety Performance Based on Current Safety Practices of both Contractors and Hosts*

Over half of respondents believe that the current most important practice that predicts future contractor safety is whether or not the contractor has a written environmental, health and safety program. (See Figure 23.)
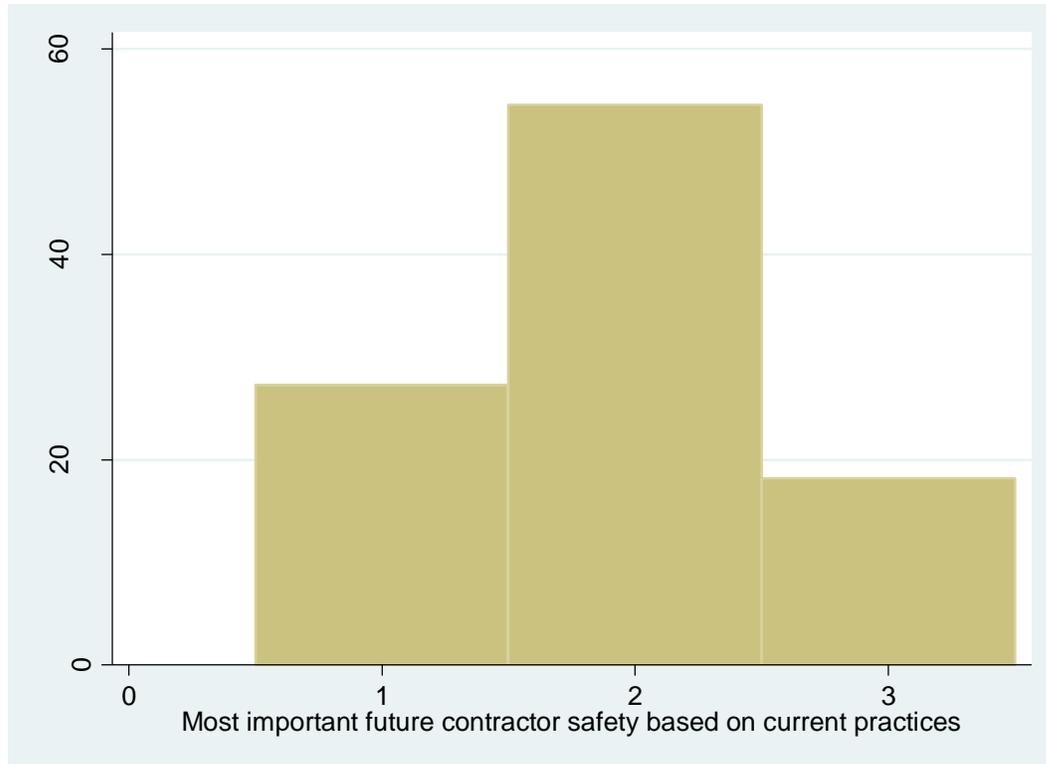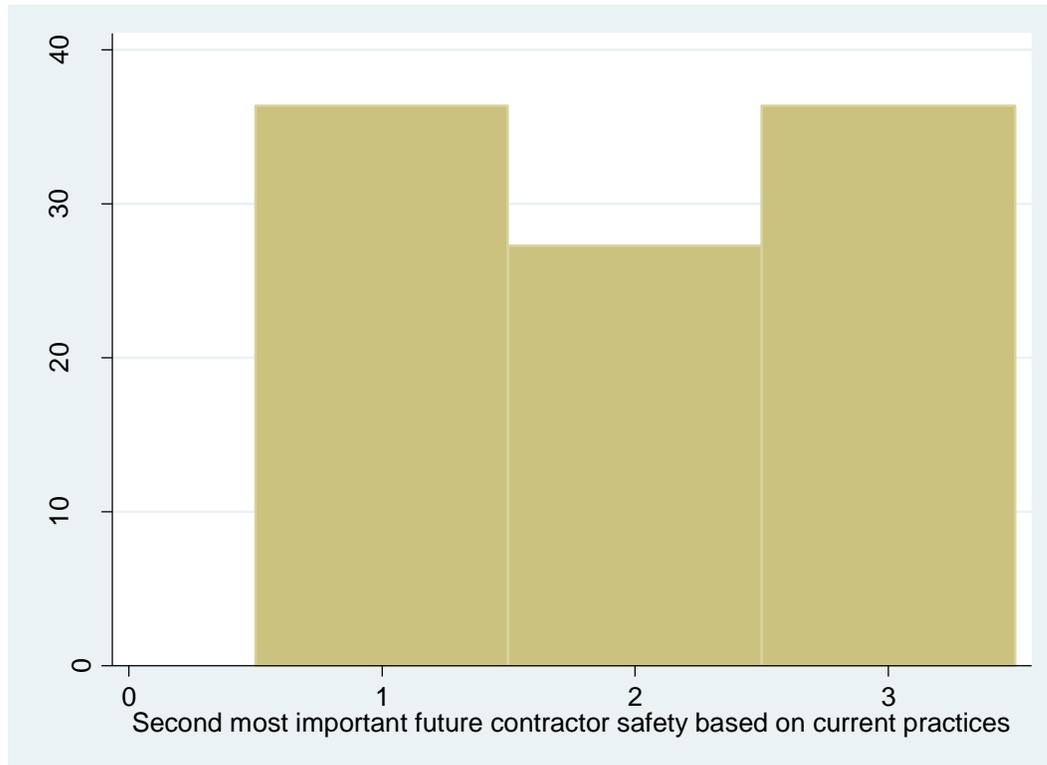
**Figure 23: Most important predictor of future contractor safety based on current contractor practices**

1. Contractor can document the completion of specific safety training for workers who he will bring onto the site
2. Contractor has written environmental, health and safety program
3. Contractor has a certified environmental, health and safety management system

Of secondary importance is whether the contractor can document the completion of specific safety training for workers who will be on his site and whether the contractor has a certified environmental, health and safety management system. An available option not chosen by any of the respondents as the most important current practice predictor is whether the contractor has indicated that he will not use subcontractors. The use or non-use of subcontractors was relegated to least important by almost all respondents.

The second most important current-practice predictor is equally divided between whether the contractor can document the completion of specific safety training for workers who he will bring onto the site, and whether the contractor has a certified environmental, health and safety management system.



**Figure 24: Second most important predictor of future contractor safety based on current contractor practices**

1. Contractor can document the completion of specific safety training for workers who he will bring onto the site
2. Contractor has written environmental, health and safety program
3. Contractor has a certified environmental, health and safety management system

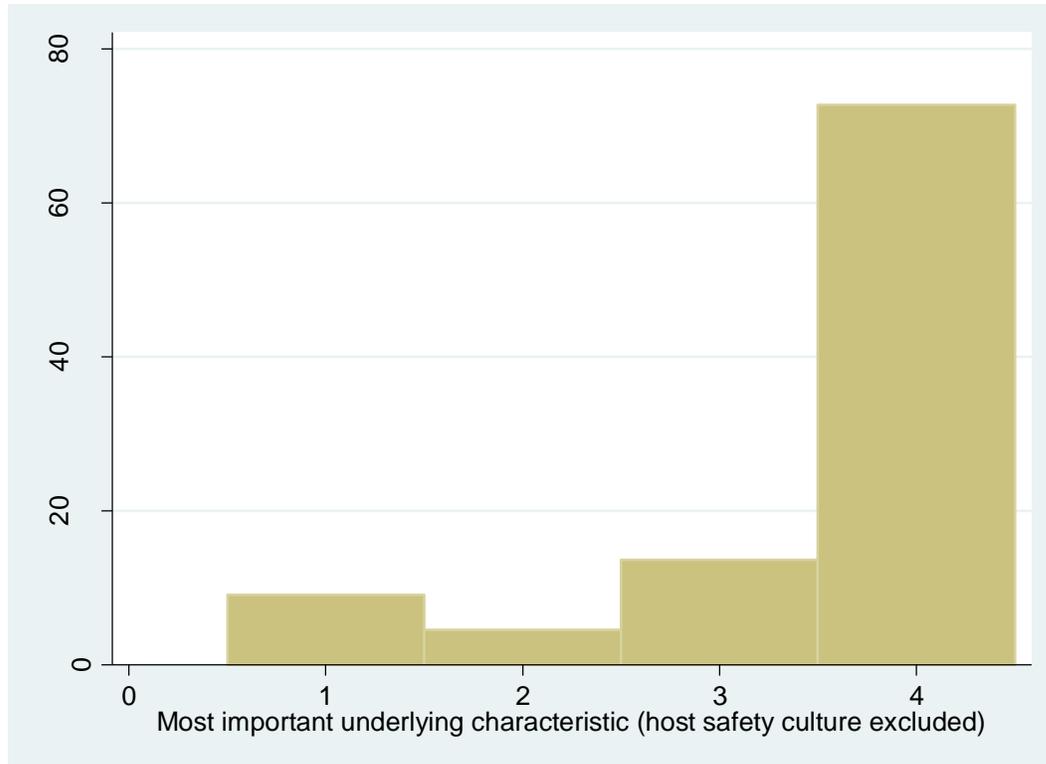## *Safety Culture, Communication and Compensation*

Respondents—health and safety executives in host employer companies—were asked: "For safety prequalification to work, rank from 1 (most important) to 5 (less important) the following underlying host and contractor company conditions:"
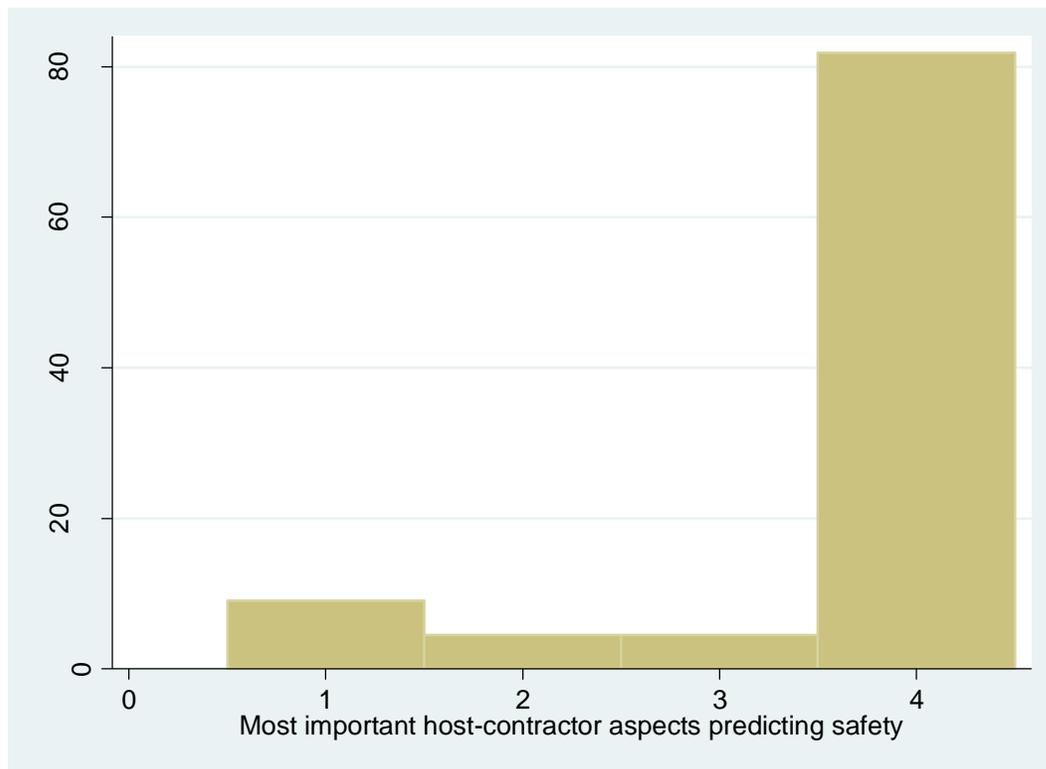


**Figure 25: Underlying host and contractor conditions needed to make safety prequalification work**

1. contractor management compensation is tied to safety performance
2. contractors are required to report safety incidents to host management
3. host management compensation is tied to safety performance
4. the host company has an effective safety culture

The respondents were all probably named Harry Truman because clearly they almost all felt that "the buck stops here." For the safety prequalification of contractors to work, first and foremost, these respondents felt that their own company's safety culture must be effective. The good news is that this is in the hands of the respondents and their colleagues to control. The bad news is that this does not directly address the question of how to separate the good contractors from the bad contractors in a safety prequalification process. There is, however, a way around this. In Figure 26, we eliminate the "host company has an effective safety culture" option substituting the respondent's second most important underlying factor. But the importance of safety culture does not go away. Now the contractor's safety culture is the most important underlying factor in predicting future safety performance.

**Figure 26: Underlying host and contractor conditions needed to make safety prequalification work excluding the safety culture of the host employer**

1. contractor management compensation is tied to safety performance
2. contractors are required to report safety incidents to host management
3. host management compensation is tied to safety performance
4. the contractor has an effective safety culture

So if real estate is location, location, location—workplace safety is culture, culture, culture. Still, culture is a diffuse concept, and we can drill down deeper looking for more specific criteria. By eliminating both culture responses we get Figure 27.
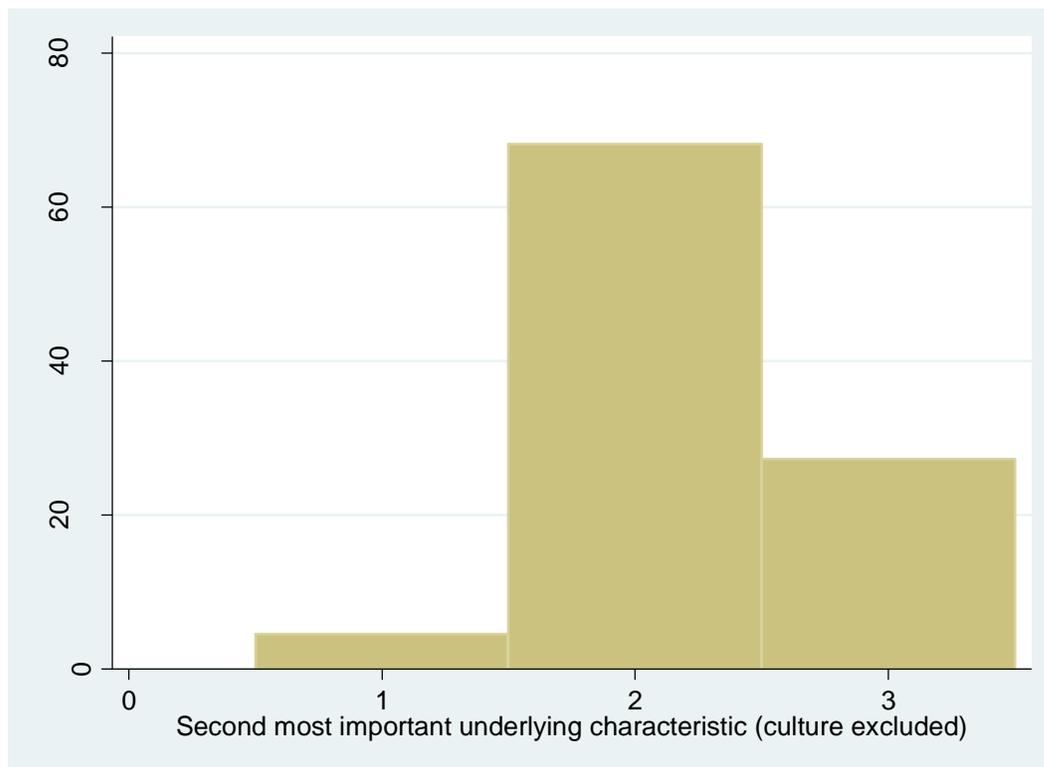
**Figure 27: Underlying host and contractor conditions needed to make safety prequalification work excluding the safety cultures of the host employer and contractor**

> 4. contractor management compensation is tied to safety performance
> 5. contractors are required to report safety incidents to host management
> 6. host management compensation is tied to safety performance

When the factors of host and contractor safety culture in general are set aside, the most important underlying characteristic in making safety prequalification work is that contractors are required to report safety incidents to the host management. Of secondary importance is that <u>host</u> management compensation is tied to safety performance, and only territorially does contractor management compensation tied to safety performance come into play. What is being revealed here is a strong conviction that the buck stops with host management. First, and foremost, host safety culture must be effective. While contractor

safety culture is the next most important factor, after that, the safety process still comes

back to host management.  They want contractor safety events reported to host

management.  They want host managerial compensation tied to safety outcome.  Only

then do they want contractor management compensation tied to safety outcomes.  The

lesson here is that while safety prequalification of contractors is about contractors

because it is about separating safe from unsafe contractors and it is about getting the

world of contractors to come up to safety standards, nonetheless, prequalifying

contractors is a host management policy that eventually must be rooted in host

management commitments and behaviors.

## *Specific Characteristics of Contractors Revealed in Field Audits or Managerial Inspections*

While more expensive to conduct than documentation audits (either in terms of

submitted documentation or obtained in office visits) field audits (which may include

office visits) provide additional specific information about contractors.  Field audits can

be conducted at worksites other than the hosts, or field audits may involve formal or

informal assessments of contractor practices on the host employer site.  Figure 28 shows

how respondents assessed the importance in predicting future safety outcomes of various

contractor characteristics revealed in a formal or informal field audit.  Because the print

in the figure is small, the x-axis categories are reproduced in a table below the figure.
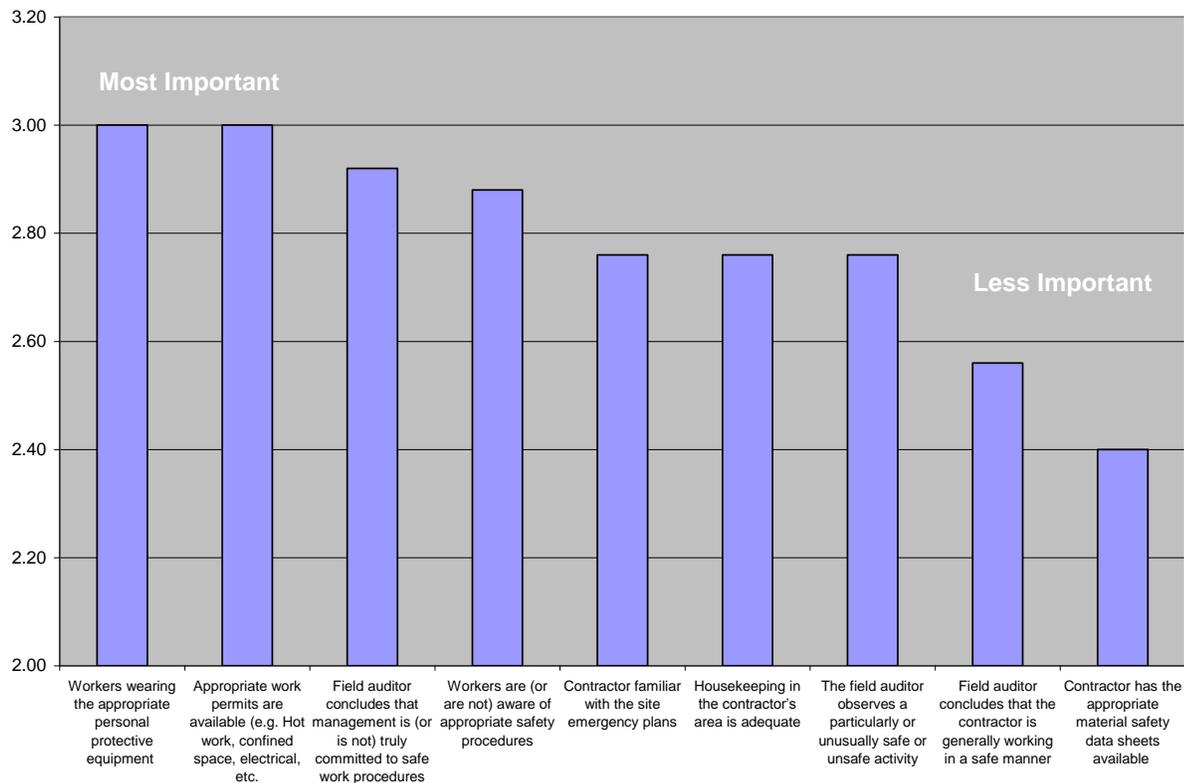
**Figure 28: Specific characteristics of contractors predicting future safety performance**

| Workers wearing the appropriate personal protective equipment | Appropriate work permits are available (e.g. Hot work, confined space, electrical, etc.) | Field auditor concludes that management is (or is not) truly committed to safe work procedures | Workers are (or are not) aware of appropriate safety procedures | Contractor familiar with the site emergency plans | Housekeeping in the contractor's area is adequate | The field auditor observes a particularly or unusually safe or unsafe activity | Field auditor concludes that the contractor is generally working in a safe manner | Contractor has the appropriate material safety data sheets available |
|---|---|---|---|---|---|---|---|---|

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The two most important contractor characteristics involve auditors (or host management) observing contract workers wearing the appropriate personal protective equipment and contractors having the appropriate work permits available. Next in importance is that the field auditor concludes that contractor management is truly committed to safe work procedures. Next in importance is that the auditor determines that contractor workers are aware of appropriate safety procedures. A step down from these factors is the determination that the contractor is familiar with the host site emergency plan and that the housekeeping in the contractor's area is adequate. At this level is also the possible observation of the auditor (or host management) that an unusually safe or unsafe activity is occurring at the time of the visit. Less important is that the auditor concludes that the contractor is generally working in a safe manner at the time of the visit, and least important is that the contractor has available the appropriate material safety data sheets. If we read these results backward, from least important to most important factor, we are moving towards factors or sets of factors that are more likely to indicate more generally that the contractor has implemented an effective safety culture within his company and among his workers. The two most important factors— that workers are wearing the appropriate personal protective equipment and that on-site management has the appropriate work permits—essentially is asking specifically at the moment of the inspection are contract workers and is contract management doing the right thing? This is essentially sampling the contractor's work culture for specific behavior at the time of the visit. Ranked slightly lower probably because it is a more subjective outcome, is the conclusion of the auditor (host manager) that the contractor is

truly committed to safety.  Thus, objectively and subjectively, the host is looking for an

effective contractor safety culture to match up to the host's own.

# Chapter 7 Analysis of RMCOEH Averaged-Sized-Host-Employer Safety Prequalification Survey

In November 2007, we collected the responses from a supplemental survey of health and safety directors and other officials from a range of companies located in the Intermountain West. These executives were surveyed regarding their contractor safety prequalification practices using a subset of the questions from our main survey of safety prequalification practices of 25 major corporations. This supplemental survey of around 200 average-sized companies was done under the auspices of the Rocky Mountain Center for Occupational and Environmental Health (RMCOEH) and will be compared here to our earlier survey of 25 very large corporations done under the auspices of ORCWorldwide. What we will be looking for here is whether average American companies approach contractor safety prequalification in a manner similar to or different from the "best of the best" large American companies.

On average the RMCOEH companies employed almost 3000 workers plus an additional almost 550 contract workers. This compares to our earlier ORC survey of major corporations where, on average, each company had almost 62,000 direct employees and almost 16,000 contract workers. The RMCOEH respondents also had, on average, 16% contract workers among all workers on site compared to 28% for the major corporations in the ORC survey. So the ORC respondents are larger and do proportionately more work with contractors. The RMCOEH survey had 219 responses with many respondents not answering all of the questions. (Table 11) Here our analysis will cover the same first seven topics covered in the ORC survey. These are:

1. The effects on safety prequalifying of short-term vs. long-term contractor relationships to host employers
2. Safety prequalification practices

3. Safety prequalification constraints on bidding

4. Reasons not to safety prequalify

5. Reasons to safety prequalify

6. Useful predictors of contractor safety based on past practices

7. **Safety culture, communication and compensation**

What we will see in this analysis is that, on the whole, average company health and safety executives view contractor safety prequalification in a very similar light to the views held by the safety executives in the largest corporations. In some cases, responses are almost precisely the same despite coming from different samples surveyed separately. In these cases, we are confident that we have captured very real current patterns about contractor safety prequalification today in the American context.

| Variable | Host Employers | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| Total number of host direct-employees | 205 | 2,986 | 11,041 | 2 | 100,000 |
| Total number of contract workers on site | 195 | 546 | 2,895 | 0 | 37,500 |
| Percent contract workers of total | 219 | 16 | 24 | 0 | 88 |
| Percent contractors working 6 months or less | 84 | 45 | 38 | 0 | 100 |
| Percent contractors working 6 to 12 months | 84 | 14 | 20 | 0 | 100 |
| Percent contractors working 1 to 2 years | 84 | 12 | 18 | 0 | 100 |
| Percent contractors working more than 2 years | 84 | 29 | 33 | 0 | 100 |
| Percent contract workers with higher turnover compared to host employees | 101 | 48 | 50 | 0 | 100 |
| Average age of host employees | 92 | 39 | 7 | 25 | 55 |
| Average age of contractor employees | 84 | 35 | 7 | 24 | 55 |
| Percent of work safety prequalified | 87 | 71 | 37 | 0 | 100 |
| Percent of contractors who do not pass safety prequalification standards | 76 | 14 | 18 | 0 | 98 |
| Average number of safety prequalified contractors on bid list | 65 | 205 | 1,238 | 0 | 10,000 |
| Percent of nested or resident contractors | 50 | 7 | 12 | 0 | 50 |
| Percent of construction contractors | 52 | 22 | 34 | 0 | 100 |
| Percent of maintenance contractors | 48 | 19 | 48 | 0 | 250 |

**Table 11: Descriptive statistics for RMCOEH survey responses**

### *Short-term and Long-term Contractor-Host Relationships.*

In both the ORC and RMCOEH surveys, the tenure of contractors on host sites bifurcated between short term residency and long term residency on-site. In both cases, more than 40% of all contractors were on site less than six months, but the next highest percentage of contractors were on site for more than two years. Figure 29 shows that the pattern of contractor tenure looks similar between the large-company ORC survey and average-company RMCOEH survey.

The issue of contractor tenure is important for our purposes because when higher percentages of contractors are on host sites for short periods of time, there will be more contractors to prequalify over time, and each contractor will typically have less work over which to spread the cost of any one safety prequalification procedure. On the other hand, when contractors are on site for more than two years, contractors will probably have to be re-qualified, but the cost of re-qualification is administratively less expensive while being more informative because much information about the contractor's safety performance can be based on information from their on-site work. All other things being equal, more short term contractors makes safety prequalification logistically more difficult and economically more expensive. The fact that we get the same bifurcated pattern of contractor tenure from two different surveys of two different types of host employers suggests that this bifurcation is real, in the aggregate.
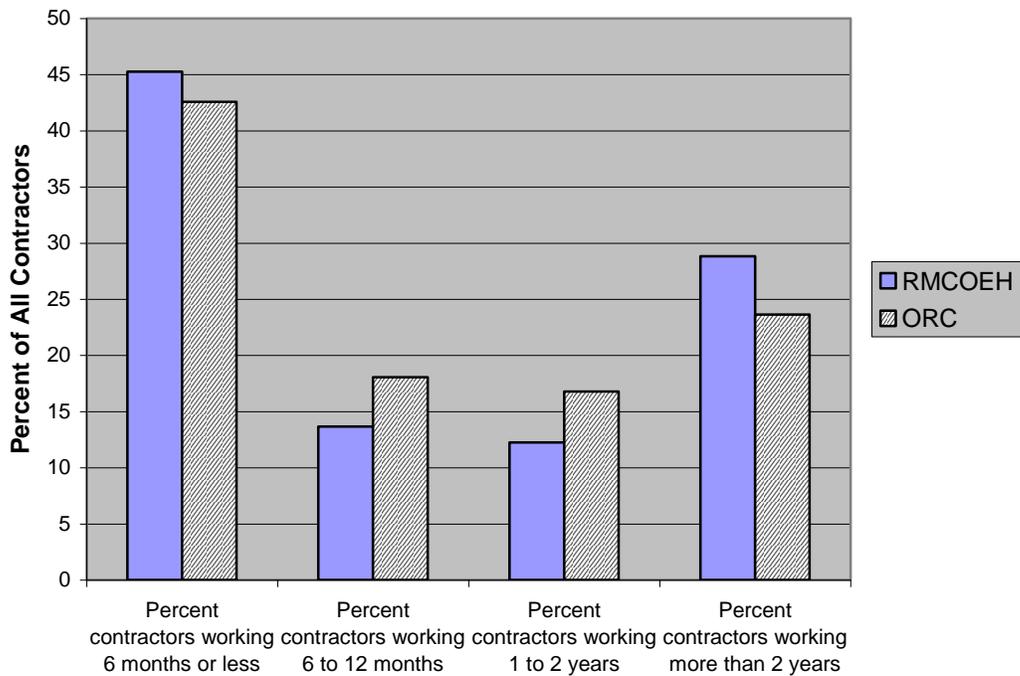
**Figure 29: Comparison of contractor tenure on host site in the RMCOEH and ORC surveys**

Figure 30 shows that the bifurcation of contractor work is, in many cases, an aggregate effect with some host employers having just short-term contractors and other hosts having just long-term contractors and still others having intermediately tenured contractors. Figure 30 is a scatter graph with each dot representing one host employer, and with the size of each dot representing the own-employment size of each host. The large dot on the lower right corner of the graph is a relative large host that has 100% of all its contractors on-site for less than six months. The smaller dot on the upper left hand corner of the graph is a moderately sized host that has 100% of its contractors on-site for more than two years. The very large dot just below that is a large company that has about 75% of its contractors on-site for more than two years and almost no contractors on site for less than six months. When the dot is on the 45 degree line between the upper-left and lower-right corners as indicated by the dotted line, these hosts have contractors on-

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site for less than six months or more than two years but no time in-between. The one host at the graph's origin has no contractors on-site for less than six months or more than two years but rather has contractors on site for more than six months and less than two years. So the aggregate systematic structure of contractor tenure bifurcating between short-term and long-term contractor tenure is not necessarily experienced by specific hosts. The importance of the aggregate pattern is that it will shape the character of contractors and contractor expectations about tenure in the overall market. The importance of the disaggregated pattern for individual hosts is that the specifics of their tenured contractor arrangements will affect the nature and the costs of their contractor safety prequalification requirements.
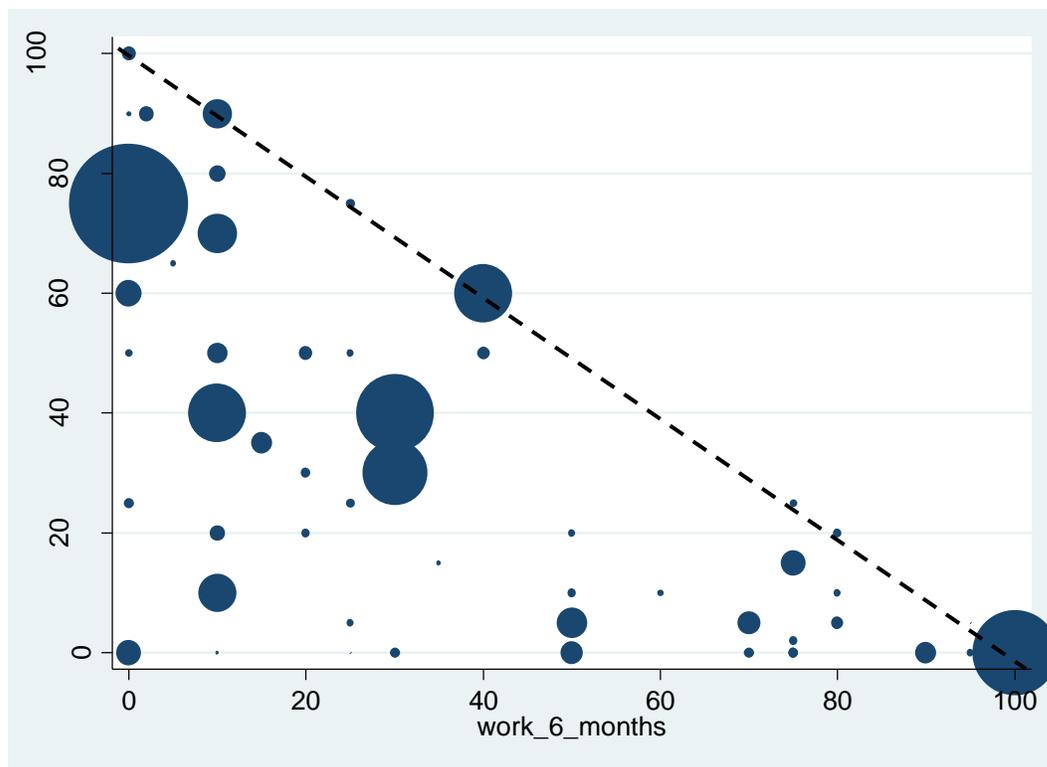


**Figure 30: Percent of all contractors working on host site less than six months or more than two years**

Table 12 provides a comparison of the mean values for key variables in the RMCOEH and ORC surveys. Notice that the average age of contract workers turned out to be exactly the same in both surveys—35 years; and similarly, the average age of host employees also turned out to be the same—39 years. This similarity in pattern yields the conclusion that contract workers are systematically younger than host own-workers and quite possibly due to their youth, contract workers may be less experienced. Should the latter be true, this is important for our purposes because younger, less experienced workers are typically more likely to get hurt and/or to hurt others on the job. This is discussed in more detail below.

Table 12 shows that ORC companies are, on average, 20 times larger than RMCOEH companies measured by size of own-employment. While 20 times larger and in percentage terms using almost twice as many contract workers (28% vs. 16%), the ORC companies nonetheless maintain a bid list of prequalified contractors that is only 7 times larger. In almost 90% of the larger ORC companies, labor turnover among contract workers is higher than among the ORC own-employees. This higher contract worker turnover takes place only about half the time in the smaller RMCOEH companies. This is important because higher labor turnover, like younger age, is a predictor for less experience and greater safety risk. So relative to the age of own-workers, the safety risks of younger age are precisely the same between the RMCOEH and ORC companies (39 years compared to 35), but relative to own-workers labor turnover, the risks of contract workers are higher for the ORC companies.

| Variable | RMCOEH | ORC |
|---|---|---|
| Total number of host direct-employees | 2,986 | 61,780 |
| Total number of contract workers on site | 546 | 15,869 |
| Percent contract workers of total | 16 | 28 |
| Percent contractors working 6 months or less | 45 | 43 |
| Percent contractors working 6 to 12 months | 14 | 18 |
| Percent contractors working 1 to 2 years | 12 | 17 |
| Percent contractors working more than 2 years | 29 | 24 |
| Percent contract workers with higher turnover compared to host employees | 48 | 88 |
| Average age of host employees | 39 | 39 |
| Average age of contractor employees | 35 | 35 |
| Percent of work safety prequalified | 71 | 77 |
| Percent of contractors who do not pass safety prequalification standards | 14 | 15 |
| Average number of safety prequalified contractors on bid list | 205 | 1,415 |
| Percent of nested or resident contractors | 7 | 30 |
| Percent of construction contractors | 22 | 31 |
| Percent of maintenance contractors | 19 | 30 |

**Table 12: Comparison of RMCOEH with ORC survey**

Figure 31 shows the relationship between increasing host-employee average age and a corresponding increase in contractor-employee average age. These relationships are separated out between the RMCOEH average-sized-company survey and the ORC large-corporation survey. In both panels of Figure 31, 45 degree lines are drawn to show what it would look like if there was a one-to-one increase-correspondence—if as host-worker age rose by (say) one year, contractor age would rise by one year. This is an important question because higher host own-worker age is a predictor of the needed experience and skills on the host work-site. If hosts need more experienced own-workers, they might well need more experienced contractor-workers as well to make the overall site safe.

In both panels, the positive correlation between host and contractor employee age is less than a one-to-one correspondence. As host employee average age rises, the age of contractor employees rises more slowly. This is important to the extent that higher average age for workers corresponds to more worker experience. This means that as hosts put contract workers on the site they are putting younger workers on the site and (by assumption) less experienced workers; and as hosts find it necessary to have more experienced own-workers, they also get more experienced contract workers, *but not as much more experienced contract workers*. In short, contract work dilutes the experience pool on the host's work site which creates a risk factor that needs to be managed perhaps partially by safety prequalification criteria.[26]
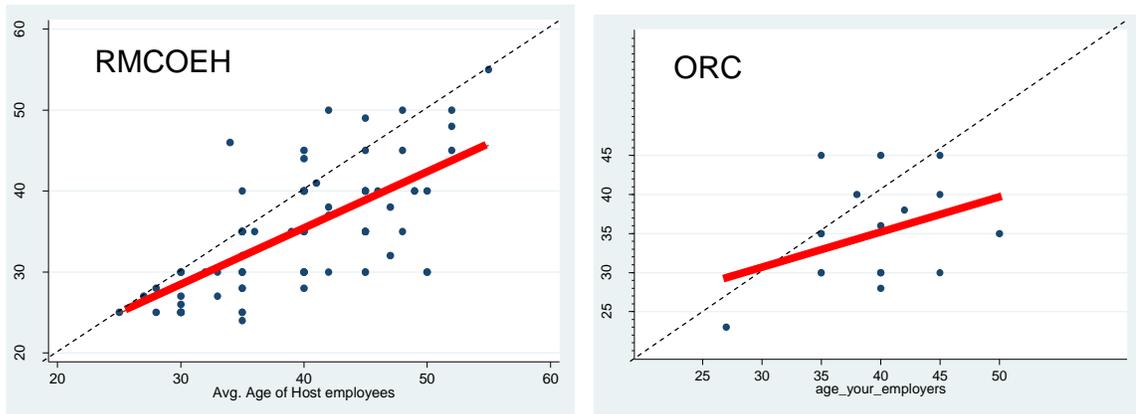


**Figure 31: The relationship between increasing host employee age and increasing contractor employee age**

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[26] An alternative explanation of these data might be that the host rids itself of younger own-workers and replaces them with younger contract-workers. Because our data do not include statistics before the host had contract workers, we cannot exclude this possibility with our data.
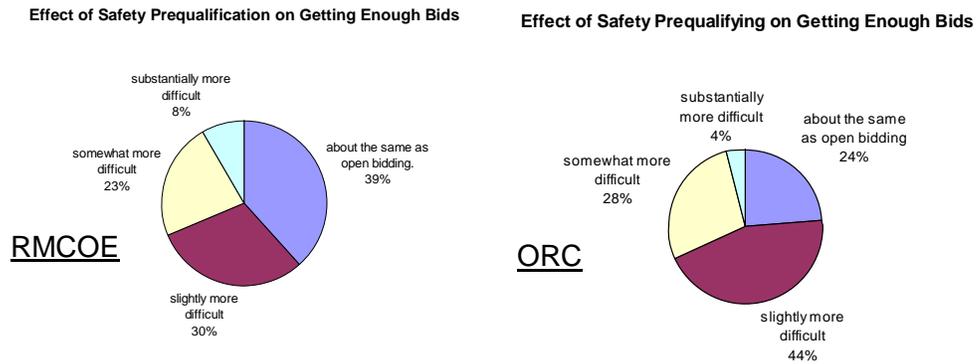
## Safety Prequalification Constraints on Bidding



**Effect of Safety Prequalification on Getting Enough Bids**

substantially more difficult 8%

somewhat more difficult 23%

about the same as open bidding. 39%

RMCOE

slightly more difficult 30%

**Effect of Safety Prequalifying on Getting Enough Bids**

substantially more difficult 4%

somewhat more difficult 28%

about the same as open bidding 24%

ORC

slightly more difficult 44%

**Figure 32: The effect of safety prequalification on bidding competition**

Host health and safety executives were asked in both surveys "Compared to open bidding by contractors, does prequalifying contractors based on safety usually make getting enough bids on a project a) substantially more difficult, b) somewhat more difficult, c) slightly more difficult, d) about the same as open bidding." Their responses are summarized in Figure 32. As Figure 32 shows, respondents in the RMCOEH survey of average-sized firms were somewhat *less* worried that safety prequalification would restrict the number of bidders on work. In the ORC survey, 24% said bidding constrained by safety prequalification was about the same as open, unconstrained bidding. In contrast, 39% of the RMCOEH survey participants thought that safety prequalification had very little effect on bidding competition. It may be that the very large corporation have specialized needs or are of a size that tends to exhaust the supply of local contractors. The fact that the ORC companies ere 20 times larger than the

RMCOEH companies yet their bid lists of prequalified contractors was only 7 times larger is consistent with the notion that their size tends to dry up pools of available contractors. More research in this area is needed. On the other hand, it may also be that safety prequalification standards for large companies are stricter. If this were so, it too would result in safety prequalification constraints having a higher likelihood of constricting bidding competition.

Our data, however, do not support the notion that large companies have stricter prequalification standards than do smaller companies. On average, 14% of the RMCOEH contractors fail to safety prequalify while 15% of the ORC contractors fail to safety prequalify. Figure 33 shows that the distribution of contractor failure by host-company looks similar between the small-company RMCOEH survey and the large company ORC survey. Some hosts have very high failure rates perhaps reflecting strict safety standards, but this does not differ in the two samples. Also remember, that prequalification failure rates can be a deceptive measure of standards if consistent implementation of high-quality safety standards in the past can result in an improvement in contractor community safety capabilities over time leading to low prequalification failure rates. In any case, our data do not indicate a difference in contractor failure rates between these two samples of very different types of host companies.
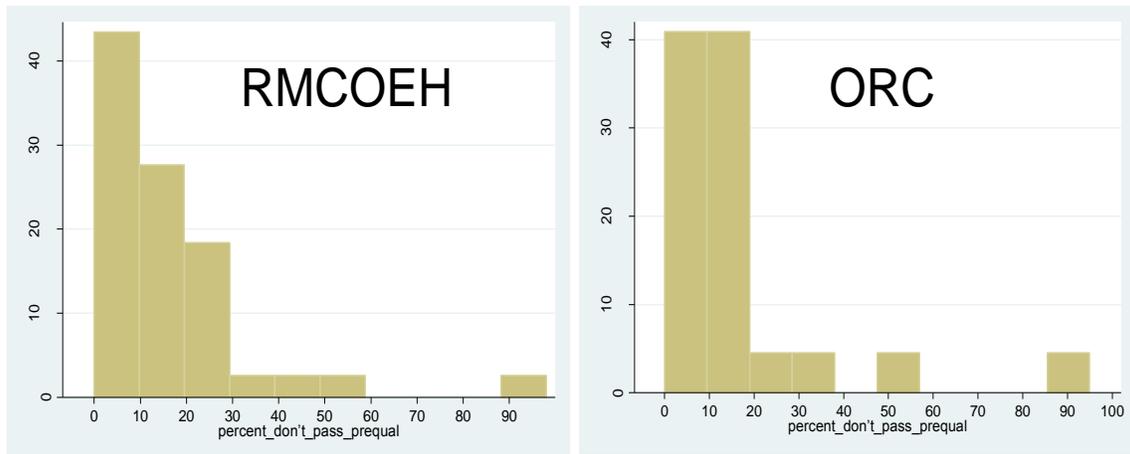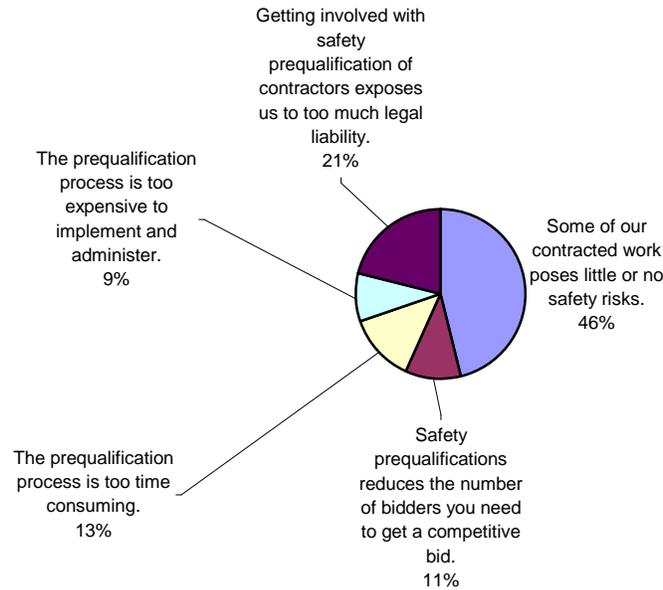
**Figure 33: Percent distribution of the percent contractors failing to safety prequalify by smaller (RMCOEH) and larger (ORC) companies. (Percent who fail on the horizontal axis and percent distribution on the vertical axis)**

## *Reasons not to Safety Prequalify Contractors*

When asked why a host employer did not safety prequalify contractors, almost half (46%) of the host employers in the RMCOEH survey said they did not safety prequalify when their work posed little or no safety risk. This response underscores that safety prequalification has costs including time and administrative costs as well as the possibility that prequalification might reduce competitive pressures raising bids on a project. So when the benefits of safety prequalification are few or absent, almost half of the responding smaller-company RMCOEH hosts do not safety prequalify. (See Figure 34.) On the other hand, 13% of the sample indicated that absence of safety risks was rarely if ever a reason, in their business, not to safety prequalify contractors. So in most cases, the tradeoff between cost and safety exists and needs to be addressed by scaling the cost of the safety prequalification process to the risks at hand. In some cases, danger is

sufficiently present that with respect to the work contracted out, absence of risk is never a reason not to safety prequalify.



The pie chart shows the following segments:

- Some of our contracted work poses little or no safety risks. 46%
- Getting involved with safety prequalification of contractors exposes us to too much legal liability. 21%
- The prequalification process is too expensive to implement and administer. 9%
- The prequalification process is too time consuming. 13%
- Safety prequalifications reduces the number of bidders you need to get a competitive bid. 11%

**Figure 34: Most common reason not to safety prequalify contractors**

When the work at hand does pose a safety risk, sometimes host employers, nonetheless, choose not to safety prequalify. Their reasons for not safety prequalifying were roughly evenly divided between a) safety prequalification reduces the number of bidders (31%); b) safety prequalification exposes the host to legal liabilities (28%); c) safety prequalification is too time consuming (25%); and d) safety prequalification is administratively too expensive (16%). (Figure 35.) These responses are similar to the ORC survey results.
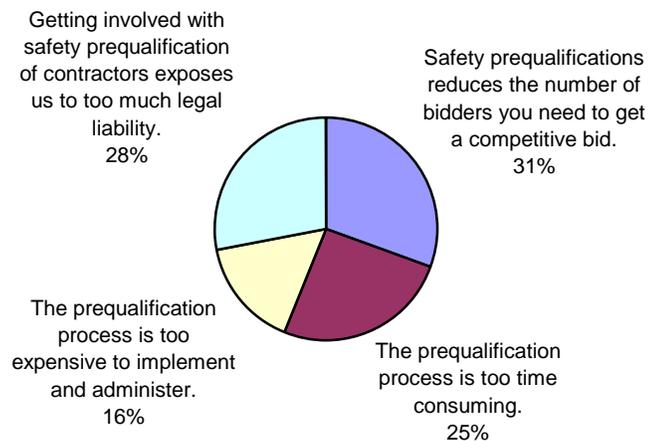
Figure 35: Primary reason not to safety prequalify even when the job poses safety risks

## *Reasons to Safety Prequalify Contractors*

When asked to rank the most important reason *to* safety prequalify contractors, the majority of RMCOEH (i.e. average-sized) host employers said it was "to align the contractor's expectations and safety culture with our own company's work and safety culture." The second most important reason for safety prequalifying was "To align the contractor's capabilities with the specific inherent safety risks of the work they will be doing." (See Figure 36, left panel.) Thus, just like the major corporate host employers in the ORC survey, most RMCOEH hosts offered aligning contractor expectations as their first reason to prequalify contractors, and aligning contractor capabilities as their second most important reason. Other competing reasons—safety prequalifying also selects for better quality work, safety prequalifying helps meet OSHA requirements and safety

prequalifying helps forestall catastrophic events, all were less important than these two "aligning" expectations and capabilities reasons for safety prequalifying. So all hosts are out to do the same thing—hosts want to square contractor safety expectations and capabilities with theirs. The devil is obviously in the details of how to get this done. This will be examined below.
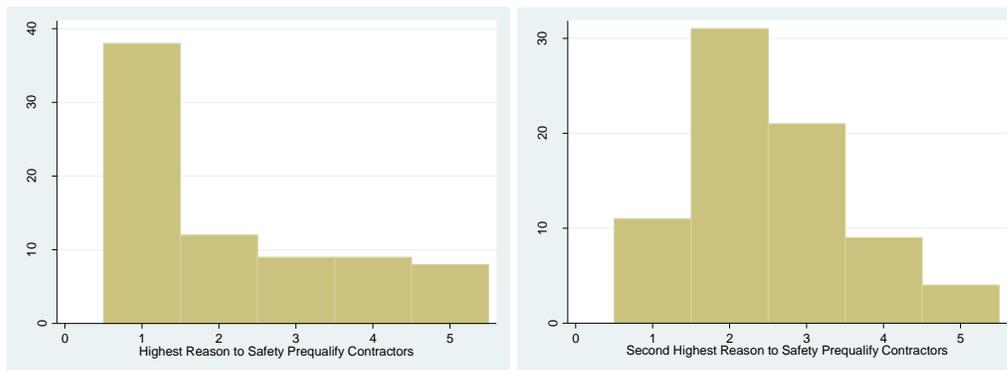


1. To align the contractor's expectations and safety culture with our own company's work and safety culture.
2. To align the contractor's capabilities with the specific inherent safety risks of the work they will be doing.
3. To meet OSHA and/or EPA regulatory requirements.
4. Safety prequalification selects for better overall contractors—so it is an indirect way of getting higher quality work delivered on time.
5. To safeguard our company against catastrophic events.

**Figure 36: First and second most important reasons to safety prequalify contractors**

While large and average-sized host employers similarly viewed aligning expectations and capabilities as the primary reasons to safety prequalify contractors, they viewed secondary reasons to safety prequalify contractors differently. In the large-employer ORC survey, the major secondary reason for safety prequalification was to get better contractors and better quality work. (See Figure 37, right panel.) On the other hand, the average-sized host employers in the RMCOEH survey were more concerned with OSHA regulatory compliance. This may reflect the fact that the ORC companies are highly visible, branded companies more concerned about their corporate reputations and product quality while perhaps the smaller companies in the RMCOEH survey are

primarily more concerned with regulatory compliance. This is not to imply that these sets of companies were not concerned with the other issue. However, they ranked their concerns differently.
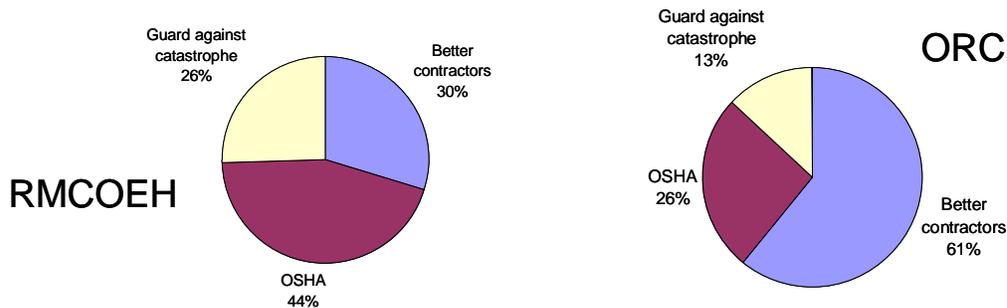


**Figure 37: Secondary reasons to safety prequalify contractors**

## *Predicting Contractor Safety Performance Based on Past Performance*

RMCOEH respondents shared with the ORC respondents the opinion that past numbers of fatalities were the single most important past predictor of future contractor safety. In both cases, about 40% of respondents listed fatalities as the most important past indicator of future performance. This opinion is interesting, in part, because fatalities are relative rare events compared to injuries. Rare events are always more difficult to predict and past contractor track records on fatalities are sufficiently sparse as to make for volatile predictors. This sparseness of past fatalities is one reason many are interested in measuring "near-misses" as past events useful in predicting future outcomes even though near-misses are difficult to define or measure and susceptible to under-reporting. Nonetheless, the unanimity of opinion regarding the importance of fatality data across surveys probably reflects the possibility that while fatalities may be difficult

to predict or use as predictors, they may be the best indicators at predicting truly adverse future events.

It is interesting to note that more than 20% of the RMCOEH respondents felt that OSHA citations and fines were the most important past predictor of future safety while in the ORC survey, no respondent listed OSHA citations as the most important past indicator. This result resonates with the previously mentioned outcome that RMCOEH respondents rated more highly reducing OSHA citations as the main secondary reason to safety prequalify contractors in the first place.
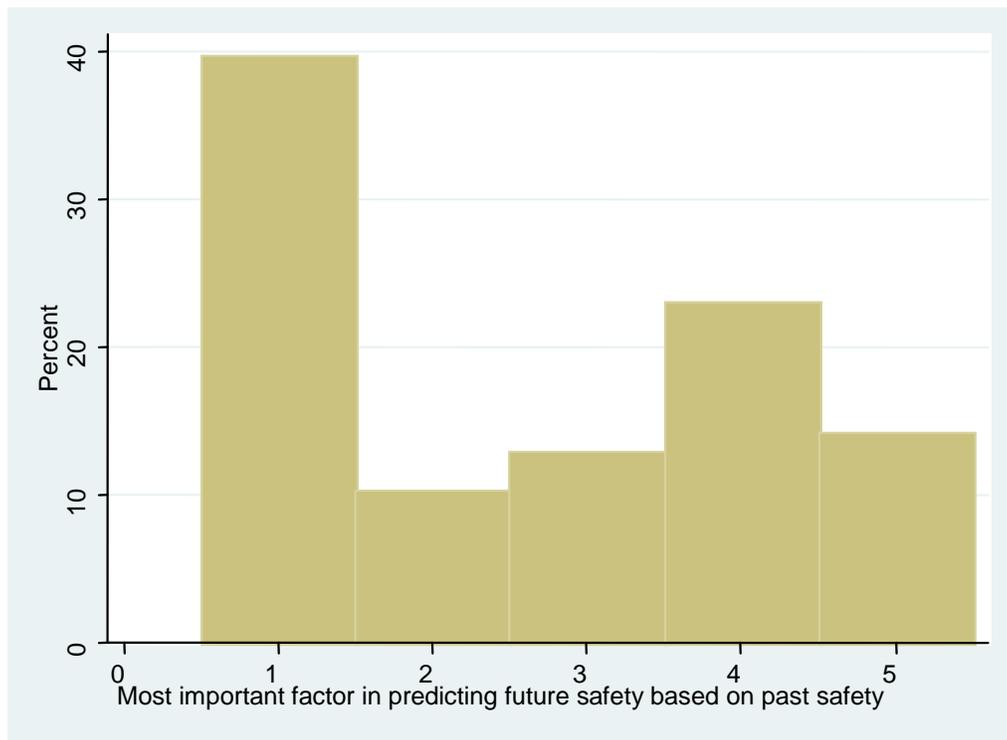


1. Number of fatalities

2. Lost work-day incident rate

3. Workers comp experience modification rate (EMR)

4. Number of OSHA citations and value of fines

5. Other

**Figure 38: The most important predictor of future safety based on past contractor safety**

When asked—what was the second most important factor in predicting future contractor safety performance based on past performance—RMCOEH respondents again agreed almost precisely with ORC respondents.  In both cases, 40% said that the contractor's lost workday injury rate was the second most important indicator.  Taken together, these responses from two surveys paint a clear picture.  In considering past contractor safety (as opposed to current contractor safety capabilities), health and safety officers at host employers look first to past fatalities, and then to past serious injury rates to predict future contractor safety behavior.  The former is an indicator of potentially serious or catastrophic future events while the latter provides a more common, less sparse, set of past outcomes with which to predict the future.  Once RMCOEH respondents had listed fatalities and lost workday injury rates as key predictors, they, like their ORC counterparts were evenly divided regarding EMR rates, OSHA citations and other possible past indicators of future safety outcomes.
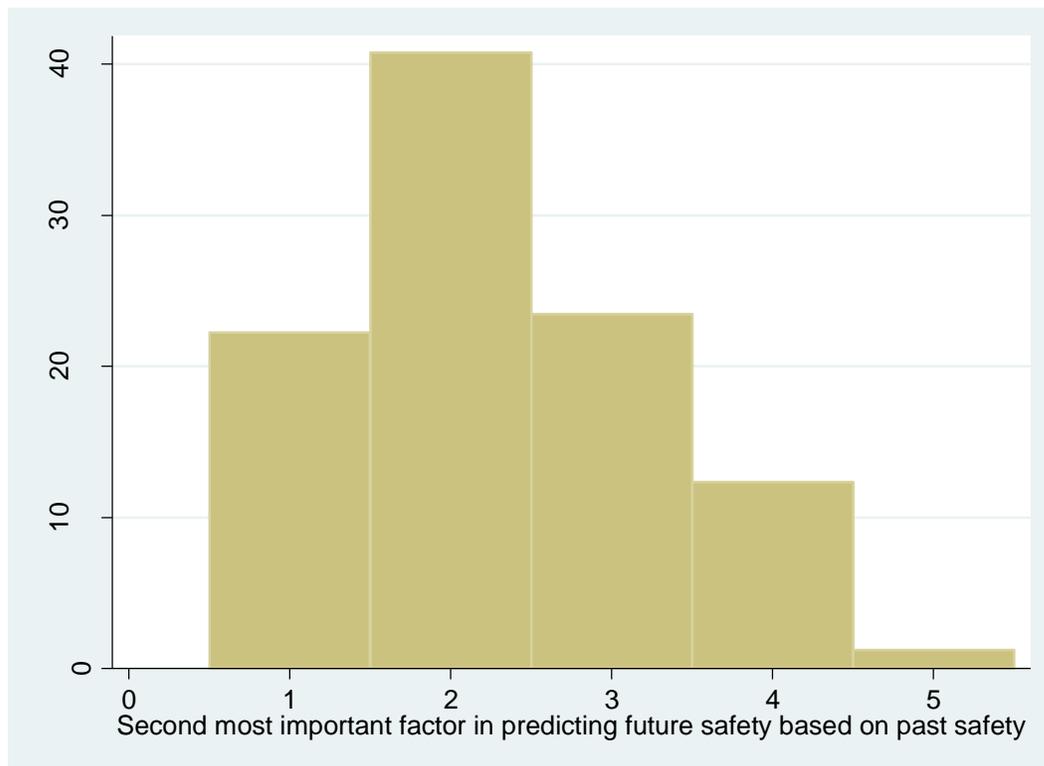
1. Number of fatalities

2. Lost work-day incident rate

3. Workers comp experience modification rate (EMR)

4. Number of OSHA citations and value of fines

5. Other

**Figure 39: Second most important past predictor of future contractor safety**

## Predicting Contractor Safety Performance Based on Current Safety Practices of both Contractors and Hosts

Once again, when asked what *current* contractor practices best predict future contractor

safety performance, RMCOEH responses were quite consistent with previous ORC

responses. In the RMCOEH case, over 40% these typical firms said that the most

important current practice is that the contractor has a written environmental, health and

safety program.  Another 35% said that the most important factor was that the contractor

had a certified ISO 14000 environmental health and safety management system.  Thus,

75% of RMCOEH respondents were looking for an in-place, documented, quality, health

and safety plan.  In the ORC survey, this opinion accounted for about 55% of the

responses to this question.  The difference between the two sets of responses is that

among ORC respondents, about 25% were first, and foremost, looking for documented

evidence that the contractor's workers had completed specific safety training.  Only 10%

of RMCOEH respondents saw contractor safety training as the foremost in importance.

This may be due to disproportionately more dangerous worksites among some of the

ORC respondents especially in the chemical and refining industries.
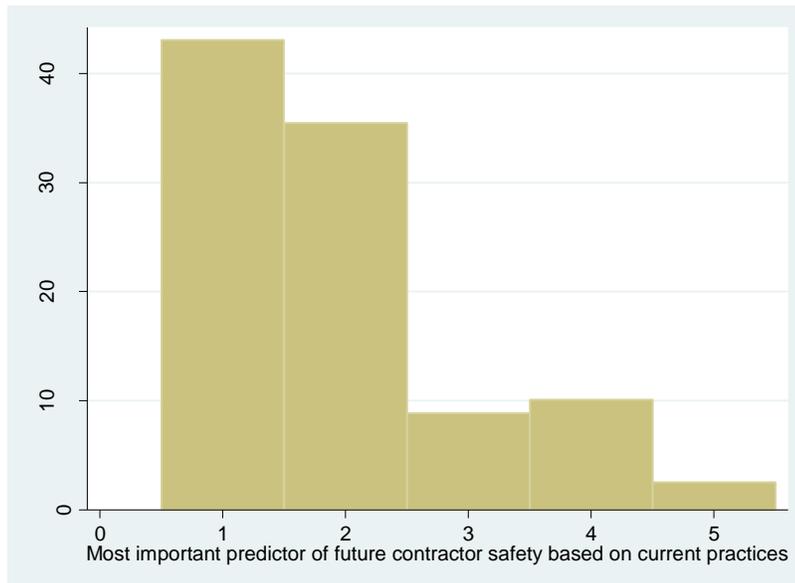


1. Contractor has a written environmental, health and safety program.

2. Contractor has a certified ISO 14000 environmental, health and safety management system.

3. Contractor has a certified ISO OSHA Voluntary Protection Program environmental, health and safety management system.

4. Contractor can document the completion of specific safety training for workers who he will bring onto your site.

5. Contractor states he will not use subcontractors.

**Figure 40: Most important predictor of future contractor safety based on current contractor practices**

## *Safety Culture, Communication and Compensation*

In our analysis of the ORC survey with respect to what would make contractor safety prequalification work, we said that all respondents were probably named Harry Truman because the safety "buck stopped here," with them. When asked what was the most important single factor regarding host characteristics/capabilities or contractor characteristics/capabilities that would insure the success of contractor safety prequalification, about 70% said the *host* company needs to have an effective safety culture. This is interesting because these host health and safety executives could have put the onus on the contractor, but they took the responsibility themselves. And indeed about 10% did—saying the single most important characteristic for contractor safety prequalification success was that the *contractor* had an effective safety culture. But most safety executives said the buck stops here. (See Figure 41.)
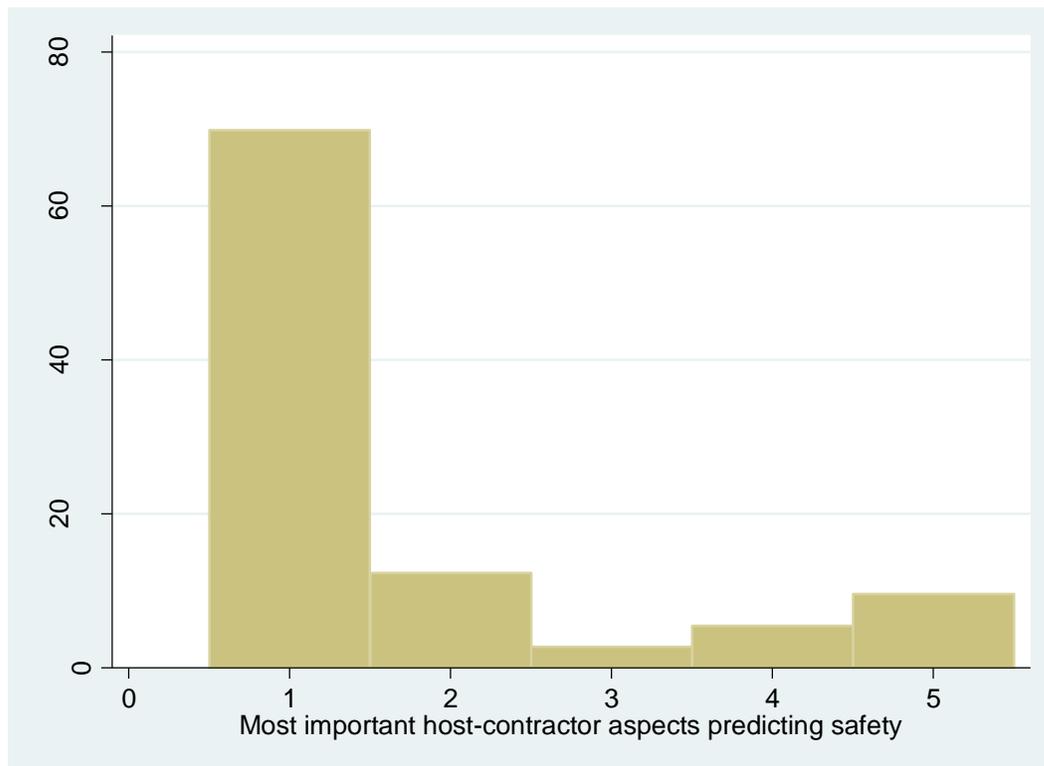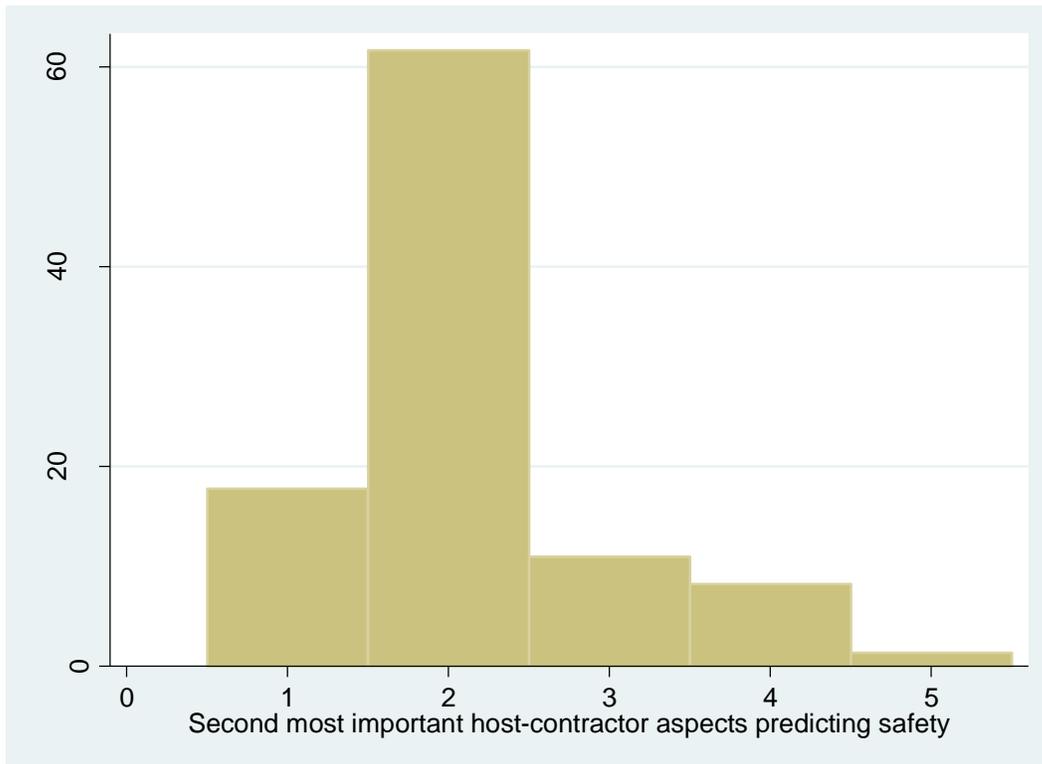
1. The host company has an effective safety culture.

2. The contractor has an effective safety culture.

3. Contractors are required to report safety incidents to host management.

4. Host management compensation is tied to safety performance.

5. Contractor management compensation is tied to safety performance.

**Figure 41: Most important host and/contractor attribute that will make contractor safety prequalification work**

Having taken the responsibility for contractor safety prequalification success,

nonetheless, host executives then loaded onto the contractor the second most important

factor—that the contractor has an effective safety culture.  Over 60% of host executives

said that contractor safety culture was the second most important factor in the success of

contractor safety prequalification.  Basically, these were the respondents that ranked their

own safety culture as most important. Conversely, those who ranked the contractor's

safety culture first, now (for the most part) ranked their own safety culture as the second

most important factor. These responses and the ordering of responses is entirely

consistent with what we found for major corporations in the ORC survey. As we said

there, if real estate is location, location, location—safety is culture, culture, culture.

Accident reporting requirements, tying host management salaries to safety outcomes

and/or tying contractor management salaries to safety outcomes were all seen as

secondary to these overall cultural preconditions for safety.

1. The host company has an effective safety culture.

2. The contractor has an effective safety culture.

3. Contractors are required to report safety incidents to host management.

4. Host management compensation is tied to safety performance.

5. Contractor management compensation is tied to safety performance.

**Figure 42: Second most important host and/contractor attribute that will make contractor safety prequalification work**

## *Summary*

Statistical outcomes gain credibility when they are consistent across separate surveys. In this case, we separately surveyed two different samples of company health and safety officials. The first sample had fewer responses (25) but surveyed the very largest companies in the United States. The second sample had more responses (about 200 in all but with around 80 usable responses for most questions) and surveyed smaller and more

typical American companies from one area in the United States—the Rocky Mountain West. Despite the differences in sample size and composition, in most cases, responses to the same questions generated very similar results. Contractor tenure on host sites bifurcates in the aggregate with short-term tenure being the most common and very long term tenure (two or more years) being the second most common relationship. This is important because the logistics, administrative costs, and needs of safety prequalification will differ depending on how long the contractor will be on-site. Host workers are older and probably more experienced than contract workers. Furthermore, as hosts require their workers to be even older and more experienced, the age of contractor-workers rises also but not as much. Taken together these facts mean that, all other things being equal, contract workers are more vulnerable to accidents on the host's site due to less experience. Contractor safety prequalification failure rates are the same across the RMCOEH and ORC surveys running around 14%; nonetheless, the ORC executives are more concerned that contractor safety prequalification will limit competitive pressure on bids. This may in part be due to the fact that while, in our samples, the ORC companies were 20 times larger than the RMCOEH companies, the bid lists for these larger companies were only 7 times larger. It may be that as companies get very large, their needs overwhelm contractor supply making the issue of whether contractor safety prequalification further restricts supply more worrisome. Both the RMCOEH respondents and the ORC respondents saw contractor safety prequalification as a means to align contractor expectations and capabilities regarding safety performance with the needs of the host employer. Both ranked setting contractor expectations as primary. And this makes sense, once expectations are understood, capabilities should follow. Putting

the horse in front of the cart, hosts see contractor safety prequalification as a two-step

process of improving contractor safety outcomes with the procurement process as a

means of getting this done.  In selecting contractors based on past safety performance,

hosts first look to past fatalities on the contractor's watch.  These numbers are necessarily

sparse, and when they exist, they may be simply due to bad luck.  Nonetheless, fatalities

are not typically under-reported and they are by definition serious.  So when they exist,

they are an important warning sign indicating more attention needs to be paid to the

suspect contractor.  Both ORC and RMCOEH contractors believe that past lost workday

injury rates are the first place to look after fatalities in examining more closely the past

safety record of contractors.  Other possible measures including EMRs and OSHA

citations are of less importance.  In terms of current capabilities, hosts are looking for

contractors to have a safety plan—a preferably certified safety program.  We were

surprised that neither the ORC respondents nor the RMCOEH respondents weighed

highly a contractor commitment not to use subcontractors.  This may mean that hosts

believe that the seemingly daunting issue of safety prequalifying subcontractors is not

that important an issue.  Or it may mean that they think the subcontracting "buck" lands

on the contractor and not on themselves.  In any case, the issue of subcontractors

warrants more research.  In the end, as we have indicated, the effectiveness of contractor

safety prequalification boils down to culture—the safety culture of the host and the safety

culture of the contractor.  If safety is truly a corporate value and goal not subordinated to

other goals or forgotten in the rush to produce, then the details of contractor safety

prequalification can be worked out.  If safety is not a priority, then contractor safety

prequalification will have trouble meeting its objectives.