# "Standard of Care" for Coatings Inspection

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Abstract: This paper will explore the concept of a "Standard of Care" as applied to coating inspection on industrial coatings projects. Establishing a "Standard of Care" for coating inspection sets an expectation for those providing, procuring or otherwise interacting with inspectors on an industrial coatings job.

The paper will present data and anecdotal evidence suggesting that the range of expectations for coating inspection may have a significant cost impact on industrial coatings projects. Defining one or multiple levels of inspection based on issues such as the type of oversight, degree of sampling and level of authority may lead to more cost-effective coating projects.

## Introduction

Those who have been in the industrial coatings business for any significant period of time have probably heard of (if not directly experienced) conflict between an inspector and coating contractor which goes beyond what a reasonable person would consider appropriate. The issue has received attention in internet discussion groups, magazines and conferences. Many versions of these stories conjure up images of the persistent inspector looking for that last grain of dust on a well prepared blast or engaging in debate over whether a few square inches of a structure observable only with an inspection mirror meets an SP-10 or SP-6 cleanliness. Other versions of these stories vilify contractors who routinely present surfaces for approval which clearly do not meet the specification requirement or who provide scant time and access to surfaces for proper inspection. There are certainly a number of ways which inspectors and contractors can, within the written rules, make the others job extremely difficult and costly.

In many cases this may be due to differences in the experience of the parties, personality conflicts, or fostering of an "us versus them" attitude at higher levels in the owner/contractor/inspection organization. On jobs with little conflict, there is often an understanding by all parties of what is customarily acceptable. Rarely does this understanding comply with the letter of the specification and quite often it varies by structure type and location on a structure. This paper will explore the idea of an efficient working relationship between an industrial coating inspector and coating contractor.

## Minimizing Conflicts

Palo[1] emphasizes the importance of clear and effective communication at minimizing job site conflicts. This requires a spirit of openness and co-operation between all parties. For example, when a contractor or inspector first senses potential conflict or discrepancy between the work requirements and common

[1] Palo, Jonathan, Effective Relationships Between Applicators, Inspectors, Owners and Coating Manufacturer Representatives, JPCL.

practices, the issue should be discussed and, ideally resolved. In dysfunctional relationships, such issues may not be acknowledged until there is a “gotcha” moment that one party can use to their advantage.

A recent National Shipbuilding Research Program project investigated ways to reduce the cost of shipbuilding and ship repair by re-engineering the way shipyards and owners perform QA and QC.[2] The project included a web-based survey to determine the opinion of industry professionals regarding the cost, ambiguity and effectiveness of various inspection processes. Survey participants were asked to rank a variety of possible non-conformities and inspection processes in various dimensions. Fifty-eight respondents replied to the survey. The respondents were equally divided among engineer/designers, production/quality control personnel, and owner representatives/quality assurance personnel. More than half of the respondents reported having at least 20 years’ experience.

**Table 1 - Relative Likelihood for Dispute among various Coating Inspection Tasks during Shipbuilding and Repair**

| Dispute Likelihood | Never | Infrequent | 1 in 100 | 1 in 20 | 1 in 5 | Half | Always |
|---|---|---|---|---|---|---|---|
| Degree of Flash Rusting | 2% | 16% | 9% | 27% | 18% | 20% | 7% |
| Visual Surface Cleanliness | 0% | 31% | 16% | 16% | 27% | 11% | 0% |
| Visual Surface Irregularities (weld splatter edge prep etc) | 2% | 39% | 2% | 30% | 14% | 11% | 2% |
| UV Surface Cleanliness (oil grease etc) | 5% | 26% | 21% | 21% | 23% | 2% | 2% |
| Surface Salts (Conductivity Measurement) | 9% | 33% | 7% | 21% | 14% | 14% | 2% |
| Anchor Profile (Comparator) | 7% | 39% | 7% | 15% | 20% | 10% | 2% |
| Dry Film Thickness (SSPC PA-2) – System | 5% | 41% | 7% | 20% | 16% | 11% | 0% |
| Dry Film Thickness (SSPC PA-2) – Primer | 5% | 41% | 7% | 25% | 11% | 11% | 0% |
| Dry Film Thickness (SSPC PA-2) – Intermediate Coats | 5% | 41% | 9% | 20% | 14% | 11% | 0% |
| Surface Salts (Chloride Measurement) | 11% | 32% | 7% | 25% | 16% | 9% | 0% |
| Dust (Tape Test) | 7% | 38% | 19% | 12% | 10% | 10% | 5% |
| Dust (Visual) | 7% | 40% | 14% | 16% | 9% | 12% | 2% |
| Visual Holiday Detection – Intermediate Coats | 7% | 43% | 11% | 16% | 14% | 9% | 0% |
| Anchor Profile (Dial Depth Gauge) | 7% | 45% | 7% | 17% | 17% | 7% | 0% |
| Visual Holiday Detection – Primer | 9% | 39% | 16% | 14% | 14% | 9% | 0% |
| Visual Holiday Detection – System | 7% | 43% | 14% | 14% | 16% | 7% | 0% |
| Recordkeeping (report to owner) | 9% | 38% | 18% | 16% | 13% | 7% | 0% |
| Field check of coating properties (e.g. viscosity) | 12% | 35% | 21% | 16% | 7% | 7% | 2% |
| Environmental Conditions Monitoring | 9% | 42% | 13% | 16% | 18% | 2% | 0% |
| Environmental Conditions during coating application | 14% | 34% | 18% | 14% | 18% | 2% | 0% |
| Environmental Conditions during cure | 9% | 43% | 11% | 18% | 16% | 2% | 0% |
| Continuous Environmental Monitoring | 9% | 50% | 11% | 9% | 13% | 9% | 0% |
| Anchor Profile (Testex Tape) | 13% | 47% | 7% | 13% | 9% | 9% | 2% |
| Containment Integrity | 7% | 49% | 9% | 26% | 5% | 5% | 0% |
| Electrical Holiday Detection | 10% | 52% | 12% | 12% | 5% | 7% | 2% |
| Substrate Surface Temperature | 7% | 57% | 11% | 9% | 11% | 2% | 2% |
| Laboratory QA of Coating Material | 17% | 43% | 9% | 13% | 13% | 4% | 0% |
| Wet Film Thickness | 7% | 61% | 14% | 7% | 2% | 5% | 5% |

Table 1 presents a summary of the responses to a question about the likelihood of dispute related to various inspection processes. While the most common answer for most inspection processes was “infrequent,” the survey indicates that one in 20 inspection checkpoints result in a dispute. At a minimum, the dispute leads to “stand-around” for the dispute participants and the idle work crew. As the significance grows, disputes increase the cost of the project substantially by creating (possibly)

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[2] *Surface Prep QA/QC Process Improvement*, National Shipbuilding Research Program, December 2007.

unneeded rework, impacts on related trades, lack of clear objectives for other work of a similar nature, etc.

The inspection processes which have the highest probability of dispute all relate to surface cleanliness. Determining the degree of flash rusting had the highest probability of dispute. Other inspection processes with reasonable likelihood of dispute were visual surface cleanliness, conductivity measurements, UV surface cleanliness (greases, etc) and inspection for surface irregularities (weld splatter, edge prep, etc).

Coating inspection is by definition a sampling survey of work being performed by a contractor. When possible, inspectors perform quantitative tests with a defined frequency. For example, paint film thickness measurements are made with an instrument which provides a numerical reading. The inspector has clear instructions on how many measurements to make based on the total painted surface area.

Visual criteria are more difficult to quantify and thus tend to be the subject of dispute. For example, SSPC SP-10 provides little guidance on the inspection process. The standard states that inspection shall be with the unaided eye and that "materials and work areas shall be accessible to the inspector. The procedures and times of inspection shall be as agreed upon by those responsible for establishing the requirements and those responsible for performing the work." There is no guidance concerning the time of inspection or the detail of the visual inspection. Consider that a contractor may blast and prime a few thousand square feet in a shift. Assuming one inspector spends 10 seconds to carefully inspect 1 square foot, it would take over 8 hours to closely inspect 3,000 square feet of surface. Alternatively, inspecting 3,000 square feet in an hour would allow less than 1 second per square foot of observation.[3] In addition, many areas require extra effort to access (ladder, kneeling, etc.) and the inspector has other surface preparation measurements to make. Should an inspector take the time to look closely at all surfaces for small (e.g., tenths of square inches) particles of rust, mill scale, etc.? Is the inspector only required to catch larger (e.g., square inches) areas of rust and paint left behind?

**Defining Roles and Responsibilities**

Palo[1] goes on to discuss the importance of understanding roles and responsibilities on projects. For example, who is responsible for making decisions and how is documentation processed?

In most coating projects the roles of owner QA and contractor QA/QC overlap somewhat. In some industries, it is common for the contractor to collect all quality data and for the owner representative to witness, check and sign off on the data. In other industries, the officially recorded quality data is measured by the owners' representative. In these cases the contractor typically collects data for process control and verification purposes, but this data may not conform to the requirements required for the "official" data. Sometimes, the most productive relationships occur when the measurement responsibility is shared between an appropriate owner and contractor representative – perhaps by

[3] Data presented later in this paper suggests that the "average" inspector would take an hour and fifteen minutes to perform such an inspection.

dividing the area to be inspected or an "I'll measure, you record" approach. This team approach is embodied in most IMO PSPC (International Maritime Organization Performance Standard for Protective Coatings) Tri-Partite agreements.

The inspector is often referred to as the owner's representative in the field. Most people who have been involved with industrial coatings in the field understand that no job is "perfect" according to the specifications, though most jobs are "done right." As the owner's representative, the inspector is responsible for enforcing the specification. While this sounds like a clear, "black and white" responsibility, there are in reality a lot of gray areas. Some of these gray areas arise from the inspectors ability to bias sampling and measurement locations, the precision with which the various quality parameters can be measured[4] and the absoluteness with which requirements are written.

A JPCL letter to the editor provided a contractors perspective on third party coating inspection.[5] The writer discussed examples where "normal procedure" conflicted with the specification requirements which, in the examples given did not appear to add value. Indeed these are the type of issues which should be brought up as early in the contracting process as practicable – typically the pre-job meeting is appropriate. Of course, the contractor needs to understand whether it is in fact the inspector who has the authority to allow deviations from the specification of whether such changes need to be elevated to another owner's representative. The writer closed with some interesting comments about the value of a third party inspector to a contractor:

> *Inspectors that are fair, knowledgeable and able to adapt to the continually changing conditions can help troubleshoot a problem. They can help make the work go smoothly by taking care of tasks such as measuring wet and dry film thicknesses, humidity and temperature, thus freeing up the contractor to manage the crew and materials efficiently and cost effectively. Fair inspecting will drive out the less reputable contractors, which will eventually make the bidding process more equitable. We look forward to working with inspectors as a cooperating team rather than as adversaries.*

**Inspection Delay and Disruption**

One issue which often arises is the time and access required for the inspector to complete an inspection. A JPCL Problem Solving Forum asked the following question:[6]

> *Many times, a project can be held up by what seems to be unnecessary extra time spent to inspect a portion of a project. How many hours of inspection should really be required to inspect a project? Is there an "amount of time per square foot or meter" a contractor should use in estimating the amount (and cost) of the time needed for inspecting a surface?*

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[4] J. Peter Ault, *Coating Inspection Data Reproducibility*, SSPC 2010 Conference Proceedings (SSPC: The Society for Protective Coatings).

[5] A Contractor's Perspective on Third Party Coating Inspection, Journal of Protective Coatings and Linings, January 1995.

[6] How Much Inspection Is Enough?, JPCL Problem Solving Forum, September 1999.

The four published respondents discussed the variables which could impact the inspection time. Issues such as number of coats, accessibility of structure, skill of the inspector and ancillary duties assigned to the coatings inspector. One respondent (a highway agency representative) observed "Most important, the coating inspector must be managed by the owner. Consistency among the owner's inspectors is essential. The contractor needs to know what to expect and the degree of enforcement of the specifications." This statement implies that, even with the exact same specification requirements the degree of enforcement of those specifications could vary significantly. One would assume that the degree of enforcement would impact the cost to the contractor.

The time required to perform specific inspection-related actions was determined in a study performed for the National Shipbuilding Research Program (NSRP).[7] An on-line survey was developed to collect data on the level of effort required to perform various tasks associated with coating inspection for work performed in accordance with US Navy technical requirements. An invitation to complete the survey was electronically sent to 2,170 individuals who hold NBPI (Navy Basic Paint Inspector) certification. The survey contained sixteen questions in each of four topical areas: accessing the work area, documentation tasks, specific inspection tasks, and respondent demographics. Respondents were also allowed to make any general comments they wished on the topic of inspection. The survey was five pages long and designed to take approximately 10 minutes.

A total of 106 responses to the survey were received. The majority of the respondents came from a Production/Quality Control role (67.5%) followed by 28.6% who considered themselves to be in an "Owner Representative/Quality Assurance" role. Slightly over half (53.2%) were employed by a Shipyard or General Contractor, nearly a third (29.9%) were employed as the owners representative and the remaining 16.9% were employed by a painting contractor. The experience of the respondents varied fairly evenly between "0 to 5" and "Over 20" years.

Figure 1 shows the cumulative distribution of average time which respondents said was required to access the area being inspected. This would include any effort to get from the inspectors normal work location to the area being inspected. Depending on the type of project, an inspector may be located in an off-site engineering office or may be co-located with the work being performed. The chart can be used to determine the number of respondents who responded that the time required was less than some value. For example, 90% of the respondents indicated that they could access the structure being inspected in less than 60 minutes while 50% of the respondents indicated that they could access the structure being inspected in less than 30 minutes.

[7] *The Cost of US Navy Coatings QA/QC*, National Shipbuilding Research Program, July, 2011.

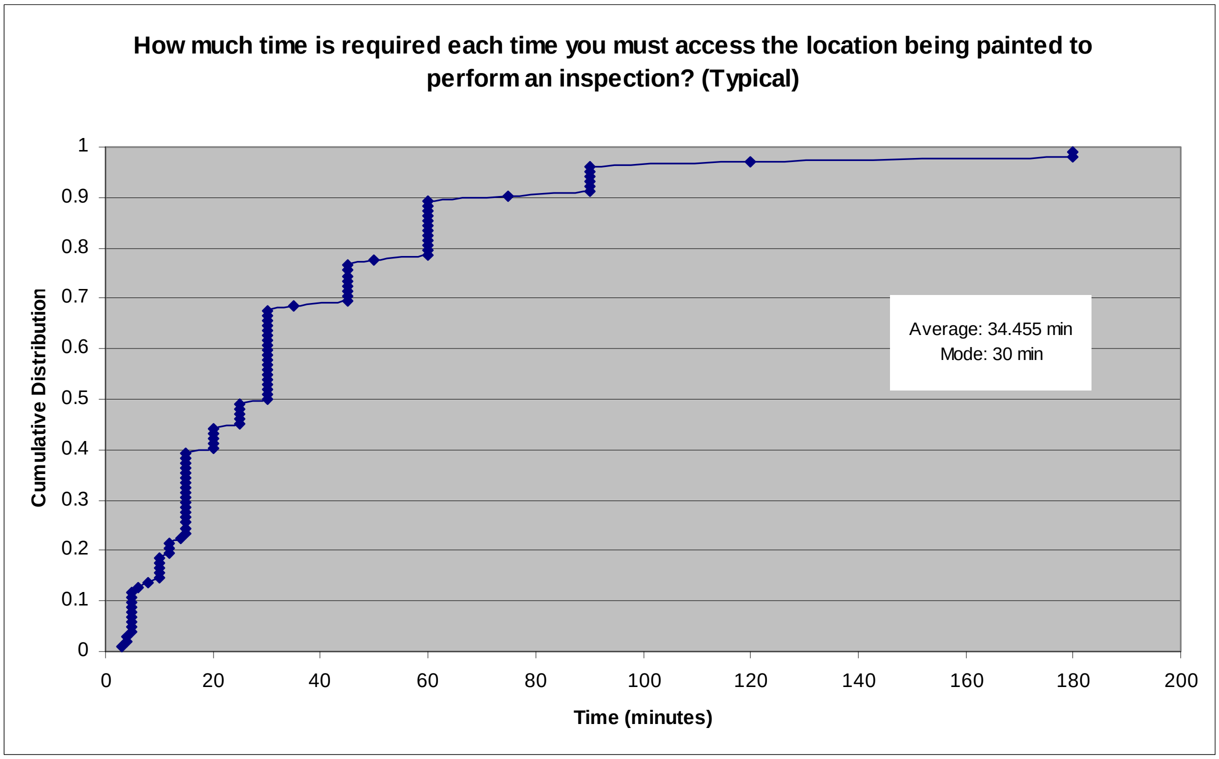


**Figure 1. Distribution of time required for an inspector to get from their work location to the surface being inspected during shipbuilding and repair.**

Figure 2 and Figure 3 summarize the responses for the time to prepare and make the various measurements required by the Navy. In these charts, the yellow bar represents the values between the 25$^{th}$ and 75$^{th}$ percentile. The vertical lines indicate one standard deviation above and below the mean while the horizontal line through the box indicates the median (50$^{th}$ percentile) response. The small black box represents the mathematical mean of the results.

Figure 2 suggests that it takes 5 to 10 minutes to prepare for most of the tests, though preparation for the dust test may be a little quicker. Figure 3 suggests that most of the tests take 10 to 30 minutes to perform once the equipment has been assembled and the inspector has gotten to the work site. Note that visual inspection of the painted surface takes the most time.

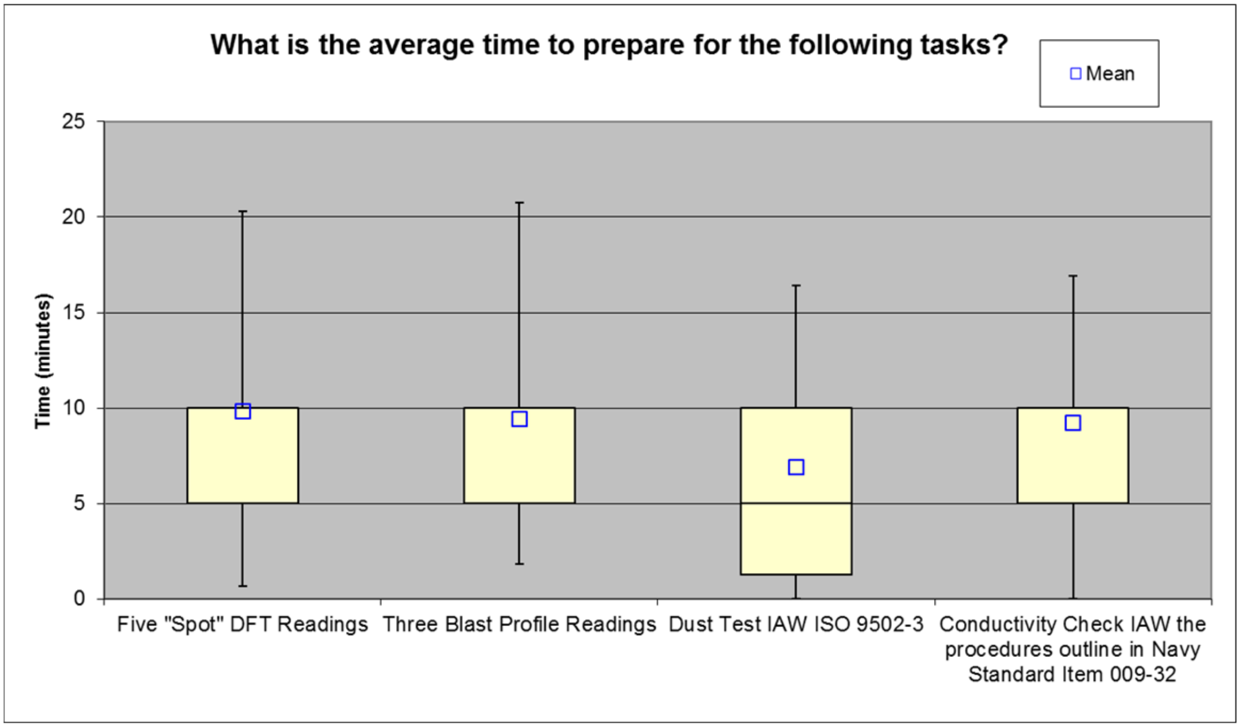


**Figure 2. Time required preparing for various coating inspection tasks during shipbuilding and repair.**

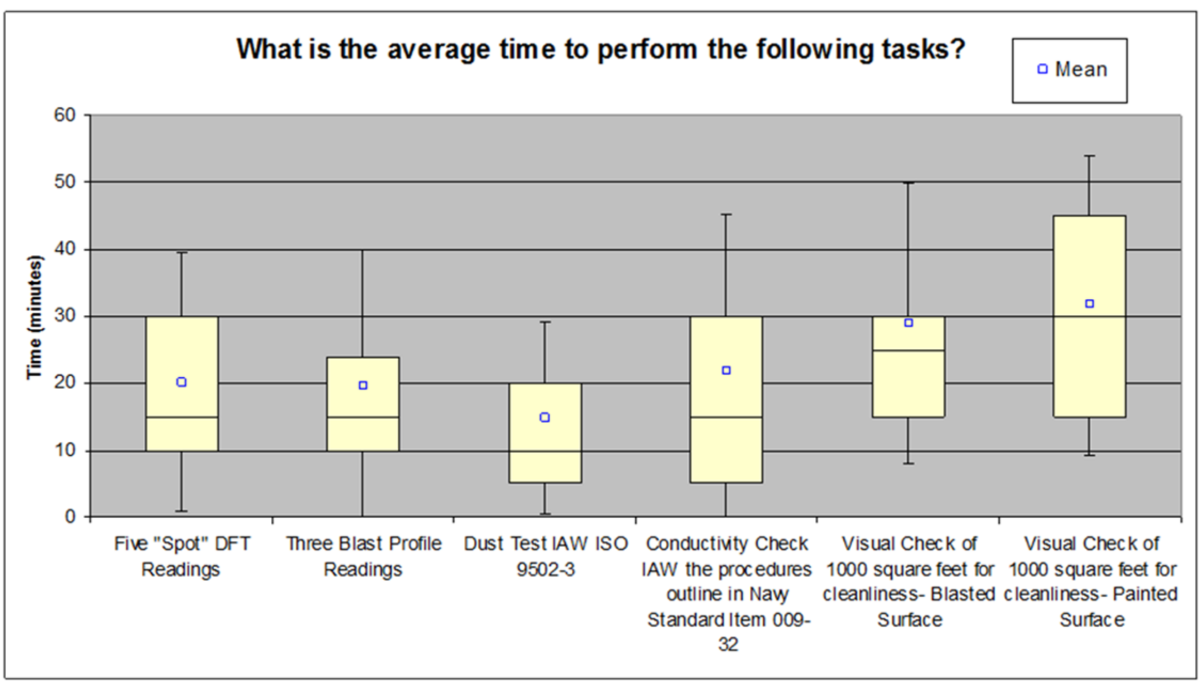


**Figure 3. Time required to perform various coating inspection tasks during shipbuilding and repair.**

To put this data into the perspective of a project, a model was developed based on the Navy's required inspection frequencies (which are quite similar to most industrial coatings project requirements). Figure 4 shows the prediction of inspection time required to access the structure, calibrate gages make measurements and record data. The analysis below specifically does not include preparation of reports as that activity does not typically impact the production. The model predicts the total inspection time required for blasting and application of a three coat system as a function of square footage based on the 1st quartile, median and 3rd quartile times predicted by the survey data.

Note that the model predicts a certain minimum amount of time for even very small jobs. This reflects the need to access the structure, prepare equipment and make some minimum number of measurements regardless of the quantity of work performed. Thus, economies of scale are achieved if larger areas are presented for inspection. Also note the wide range of predicted inspection time. The 75th percentile prediction can be as much as five times the 25th percentile prediction. Reasons for this disparity should be explored. Simply narrowing the disparity of effort could reduce some disputes and the overall cost impact of the inspection process.

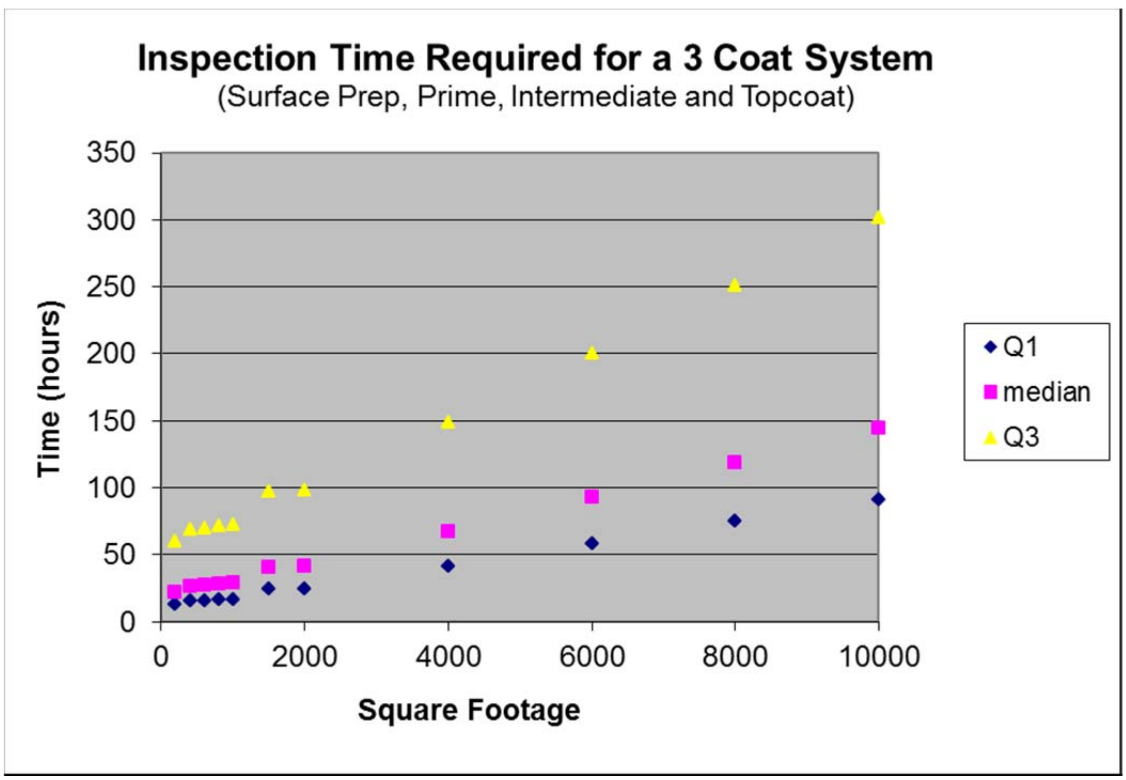


**Figure 4. Model projections of the time required to perform coating inspections on various sized surfaces during shipbuilding and repair.**

**"Standard of Care" for Coating Inspection**

In legal terms, "Standard of Care" for a professional in a given industry could be defined as the ordinary skill and competence exercised by members of a profession is good standing in the community. The problem is that the "standard" is often a subjective issue upon which reasonable people can differ. The data and anecdotes presented in this paper suggest that there is a wide range of "acceptable" approaches to coating inspection tasks. As might be expected, these varied approaches can have varying impacts on the execution of the work. To the extent that this impact is not known or understood by a prospective bidder for any given project has to have an impact on their ability to correctly bid the project and therefore may impact an owner's ability to obtain competitive pricing. Understanding the culture of a particular industry is one of the benefits of incumbency, but many of the differences observed among inspection processes are not just between industries but can be from inspector to inspector working for the same owner. Remember the earlier referenced comment from the highway engineer:

> *"Most important, the coating inspector must be managed by the owner. Consistency among the owner's inspectors is essential. The contractor needs to know what to expect and the degree of enforcement of the specifications."*

Both NACE and SSPC require certified coating inspectors to attest to a code of conduct. These attestations focus on important issues of ethics and professional integrity. However they do not (and probably should not) address the specifics of performing inspection tasks.

In 2008 a paper was presented at SSPC proposing four standard levels of inspection.[8] The authors maintained that over inspection is one of the major causes for the rise in industrial coating prices. The authors question whether the cost of increased inspection adds any value to the applied coating performance. That question has also been explored by a National Shipbuilding Research Project without a conclusive result.[9] The four levels of inspection proposed could allow an owner to adjust the level of inspection based on their perceived value. The four levels can be summarized as follows:

> Level 1 – Contractor inspection/approval (no hold points). Owner may review of contractors daily QC reports.
>
> Level 2 – Level 1 except owner may observe contractors inspections at their discretion. Owner participation in inspections shall not impede progress of work, but owner shall have the right to approve/reject work when they are present.
>
> Level 3 – Level 2 except the use of visual aids for inspection (e.g., mirrors, magnification, concentrated lighting) is allowed.

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[8] Louis G. Lyras, Dave Hatherill, and William LePage, *Proposed Standard for Levels of Inspection*, SSPC 2008 Conference Proceedings (SSPC: The Society for Protective Coatings).
[9] *The Cost of US Navy Coatings QA/QC*, National Shipbuilding Research Program, July, 2011.

Level 4 – Level 3 plus the owner conducts full inspection after the contractor quality control checkpoint. Owner approval is required prior to the subsequent step.

About the same time, The US Navy experimented with a similar concept which they referred to a "Graduated QA." The concept was to grade contractors based on their past performance and eliminate the need for selected "hold points" for the contractors with demonstrated high quality. This would be similar to moving from a "Level 4" to "Level 2" in the scheme presented above. Ultimately, the Navy could not develop an acceptable grading system for the scheme and it was abandoned.

At some level, most owners address some of the issues associated with "levels of inspection" in their contracting documents. However few contracting documents address all of the issues adequately or consistently. Contracting documents may dictate the process for hold points, sampling procedures, approval responsibility, constraints on the type of equipment to be used and so forth. They may also dictate for whom the responsible inspectors should work and how they interact with the various other parties on the job. An industry standard document is needed which either defines various levels of inspection or provides guidance to help an owner define the process. Issues which have the potential to drive cost, create conflicts, delay and disruption or confusion regarding roles and responsibilities include:

- Who performs inspection (owner QA vs contractor QA/QC)
- What level of oversight is exercised (surveillance vs continuous)
- What percent of compliance/sampling is required (100% vs 80%)
    - Measurements such as DFT, Profile and conductivity are sampling inspections while visual criteria are sometimes enforced as 100% compliance
- Statistical versus inspector determined sampling techniques
- Ability to reject based on non-compliance incidental to the inspection being performed
- Process observations (how the work is accomplished) vs resulting product observations (inspection metrics)

**Conclusions**

1. While many coating inspection specifications and standards have been improved over the past several years, there is evidence that the inspection process can vary greatly. Variability in inspection processes causes a significant number of disputes over inspection items and a wide range of time performing inspections.
2. Concepts have been explored by participants at least two industries (highway bridges and Navy shipbuilding) for multiple approaches to inspection. In neither case did the concepts change technical requirements but instead focused on the degree of oversight. The creators of these concepts believed that meaningful savings could be recognized with minimal performance risk if different approaches to inspection were taken. The industry should consider developing a guidance document or specification which addresses the inspection process.