A STRUCTURED APPROACH TO PROTECTIVE COATING ASSET MAINTENANCE MANAGEMENT

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1. SUMMARY

Throughout Australasia and the world, we are seeing more and more examples of infrastructure continuing well beyond its original intended design life. Asset managers are being asked to extend the life of their assets due to the ongoing ripples caused by the GFC. Working within ever stringent maintenance budgets, asset managers have to find structured, and value for money approaches to asset maintenance.

Maintaining existing assets and infrastructure is more economically viable than building new infrastructure, but how do you maintain an asset living on 'borrowed time'?

A detailed assessment as to the condition of the asset needs to be conducted. The baseline survey information can then be used to effectively plan future maintenance.

The future maintenance can then be:

- Budget driven
- Risk Driven
- Based on a 'Whole of life' costing
- Weighted against cost of replacement

Planning is able to be undertaken at a high level, with detail of total surface areas, total cost, adaption to budgets and area groupings by priority allowing the asset manager flexibility and control over allocated budgets.

2. BACKGROUND

Historically, Asset Managers have not given painted surfaces a particularly high priority and maintenance programs have tended to be reactive instead of proactive, leading to less than optimum results and in some cases greatly increased expenditure in the long term.

Asset Managers might conduct an annual visual survey of the protective coatings condition on their asset in order to set the scope and budget for the following year. However, this was mostly the exception to the rule and in some cases the approach was more a 'wet finger to the wind'.

This approach left painting budgets particularly vulnerable as other demands, which were backed by sound engineering arguments, became the beneficiaries of budget re-allocations.

This style of coatings condition management approach rapidly becomes untenable and ineffective as the coatings on the asset approach the end of their useful working life and the rate of coatings failure accelerates. Potentially, the maintenance work scopes become unmanageably large and even if there are no budgetary constraints, logistically, the work scopes become almost impossible to implement. What started out as a coatings management issue escalates into an increasingly intractable corrosion management problem.

Any strategy which is not driven by an electronic database is unlikely to succeed in the log term. Without the rigorous structure of a database, it is very difficult to even establish the global magnitude of an asset's maintenance scope and problems, or to record maintenance activities in an integrated and auditable manner.

3. INTRODUCTION

It is all very well having a great pile of data but it must be accessible, useable and meaningful. The real key to a data based program is to be able to collect data reproducibly and produce information that is useful to the engineer and can be exported to other programs.

Some of the key information that users of these systems need are:

- Cost to repair or rectify
- Life expectancy
- Life prediction

Not only of the protective coating, but also of the substrates.

The aim of a Coating Condition Survey is to record and make informed judgments on the current condition of the protective coating systems, forming an overall current condition of the asset(s).

Item prioritisation along with preventative maintenance of protective coatings requires an on-going responsibility to regularly capture asset condition. Identified survey epochs enable priority parameters to be put in place, with planned maintenance to be structured that align with these time-based priorities.

The systems should enforce survey and maintenance timescales, in turn, enabling the Asset Manager to produce and commit to an ongoing protective coatings maintenance schedule.

Systems such as those designed with input from leading figures in the oil & gas and manufacturing industries tend to lead the way in Risk-Based assessment of coating failure. Used in conjunction with appropriate condition surveys, these systems enable Asset Managers to prioritise maintenance requirements to ensure that available funding is spent in the most efficient manner. The costs and effectiveness of work undertaken can be monitored and assessed, enabling valuable maintenance dollars to be spent in the most effective manner.

4. METHODOLOGY

Protective coatings provide a barrier to protect assets from corrosion; however these barriers are prone to failure as a result of natural exposure, the service environment, erosion, mechanical damage, etc.

Targeted coating assessments evaluate the condition of the protective coating & estimate the service life still remaining.

The potential for failure through corrosion is determined through visually assessing the following characteristics of an item:

- Structural condition
- Extent of substrate exposed (AS 2312 or ASTM 610)
- Corrosion mode

4.1 Objective

The objective of a coating condition survey is to:

- Visually inspect and assess the condition of external coatings on assets and structures to ensure that all facilities are maintained in a fit-for-purpose condition.

The data is used to:

- Estimate the remaining life of the existing coating, evaluate the need for repairs and prioritize the work required to ensure a cost effective program.
- Assist in producing a long term coating maintenance plan

4.2 Condition & Reports

The deliverables of a coating condition survey is to provide current condition and potential for failure supported by a number of reports which are further detailed in section 7 of this paper.

- Recoating execution plan where the coating work to be completed is determined and justified through well planned and executed maintenance strategy.
    - The relevant maintenance strategies for the equipment and structures assessed (including end of life predictions, probability and consequence of failure).
    - Budget.
    - Operational requirements for availability.
- Recommended coating type for repair.
- Short and long term maintenance expenditure spend pattern.
- Equipment and structures requiring repair.

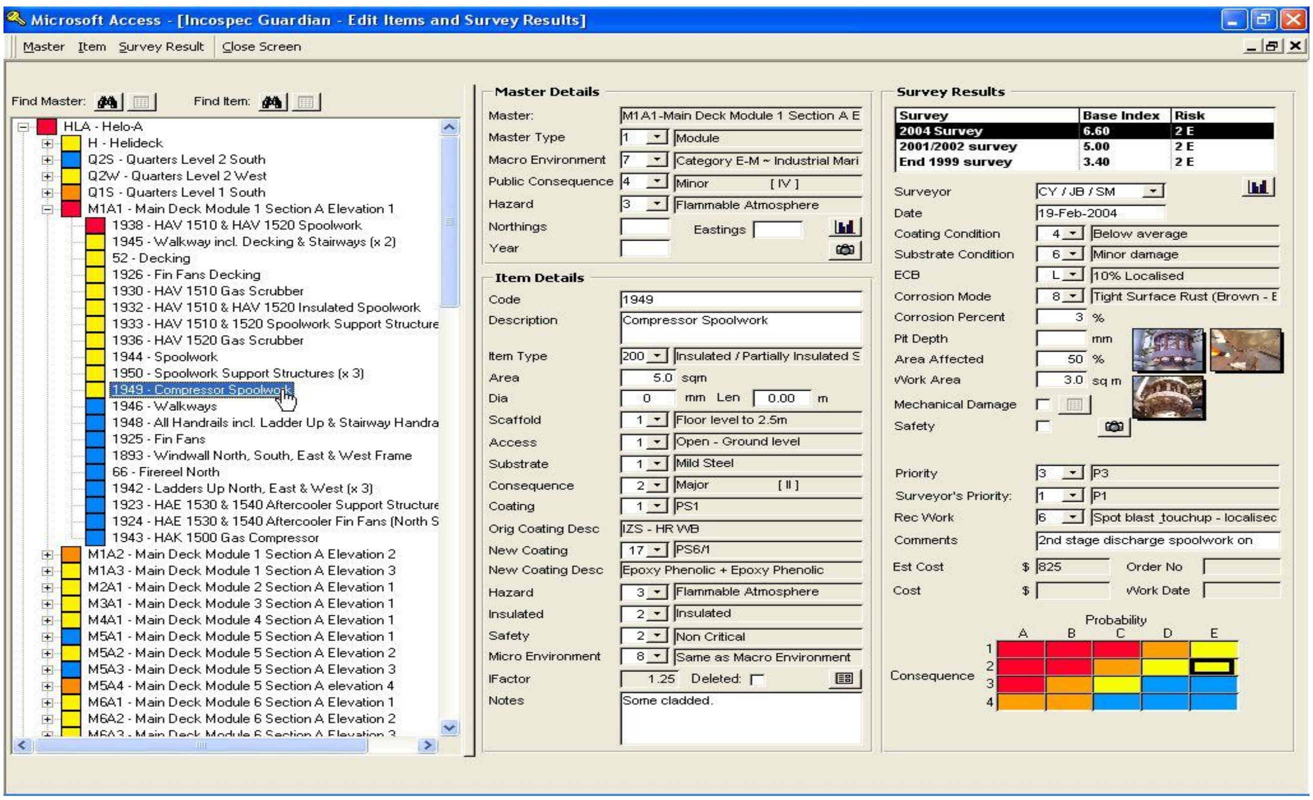
4.3 Data Storage

The consolidated data from a coating condition survey can generate a large volume of data (in excessive of 20,000 records is not uncommon). Therefore, using a computerized database is recommended for the analysis of the survey data and comparison between other surveys and inspection assessments.

An example of a computerised database using Microsoft Access Platform is shown in Table 4 below.

Note the hierarchal ‘tree’ view on Left Hand Side which breaks assets down in to ‘Master’ Areas and then further in to individual items. Survey results are recorded on Right Hand Side of image.

Table 4 – Electronic Database example (Microsoft Access Platform)



5. SURVEY PROCESS

5.1 Summary

1. Determine the coating strategy to be used with consideration for the assets remaining life.
2. Identify all the equipment and structures to be surveyed and create a list that identifies each item and describe its attributes, such as height, access, substrate, etc separately.

3. Undertake a coating integrity evaluation using three qualifiers: coating defect evaluation, corrosion mode & structural condition.

4. Use the maintenance and reliability work selection matrix to determine the requirement for any work to be carried out during the time under consideration and the assets remaining life.

5. Develop work scope.

5.2 General

To ensure repeatability of the process, inspectors for the coating integrity survey should be selected based on experience and qualification. They should have a minimum of at least 2 years experience in doing similar coating condition surveys and ACA coating inspector certificate, NACE CIP Level I certification or equivalent. There should be a formalised training process to ensure all inspectors understand the process.
These accreditations should be considered as a minimum requirement for inspectors collecting data, and should be supervised under the direction of more experienced inspectors.

5.3 Equipment Item List

To easily locate and identify the equipment in the equipment item list a standard format must be adopted when documenting these items.

These identifiers must include:

- Location
- Facility
- Description (including tag number where applicable)
- Component type
- Section
- Subsection
- Height

The development of the individual component, section, subsection and height descriptors are discussed in more detail in the sections that follow.

An exact location of the component(s) relative to the entire facility being inspected should be documented to allow the item to be relocated for remedial work and during subsequent surveys.

A detailed descriptor is collected for each item during the initial survey for that item. This descriptor is used for all subsequent surveys to allow tracking of the degradation of the coating or to track remedial action taken between surveys.

The descriptor must be the same as used in other software programs to uniquely indentify the items

5.4 Section Identifiers

Where production units have predefined nomenclatures these should be used and be consistent across all facilities for the affiliate.

5.5 Subsection Identifiers

Where production units have predefined nomenclatures these should be used and be consistent across all facilities for the affiliate.
If an item passes through more than one subsection, a record should be created for each subsection that the item traverses. The purpose of this is to allow the coating integrity to be assessed in the individual subsections and to maintain a clear delineation of the area requiring remedial work.

5.6 Height

The height of the item is an estimate of the number of scaffold stages required to reach the item. The number of scaffolding stages further assists in budget estimation as scaffolding is a major component cost in the overall project.

Elevation levels and descriptors are shown below in Table 5.

Table 5 – Elevation Levels

Elevation	Description
1	Floor level to 2.5m
2	2.5 - 5 metres
3	5 - 7.5 metres
4	7.5 - I0 metres
5	>I0 metres
6	1 bay down (hanging)
7	1 bay out
8	Bridging

5.7 Access

Difficulties in accessing items requiring maintenance will also impact the cost of the work performed. Access levels are defined as shown below in Table 5.1.

Table 5.1 - Access

Access	Description
1	Open - Ground level, open areas
2	Limited - Obstructed area: high traffic
3	Difficult - Confined space or containment including penetrations and ground entry pits
4	Hazardous Material

NOTE: An example of hazardous material may be lead based paints, asbestos, etc. This information may be used to further refine budgetary costs.

5.8 Area/Diameter & Length

This is an estimate of the physical dimensions of the item being surveyed and is used to determine if the recoating of the full item is justified based on the criteria defined in the coating strategy.

5.9 Substrate Type

The substrate type is the material of construction of the item has a corresponding number is shown in Table 5.2 below.

Table 5.2 – Substrate Type

Substrate	Description
1	Carbon steel
2	Stainless steel
3	Galvanised steel
4	Aluminium
5	Copper
6	Copper nickel
7	Concrete
8	Fibre board sheet
9	Wood
10	Fibre Reinforced Polymer
11	Plastics (ABS - PVC etc)
99	Not known

5.10 Coating Type

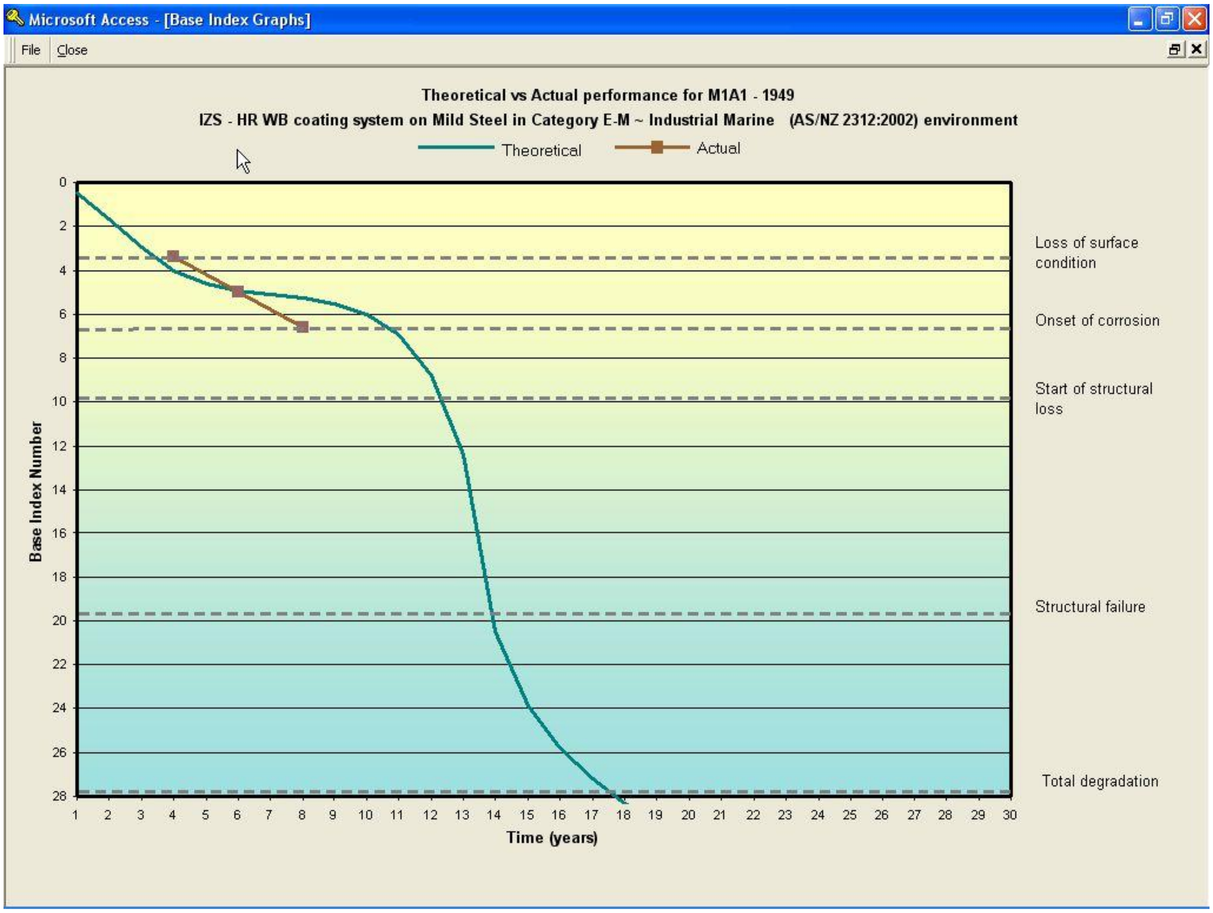
The database includes the expected performance of the coating systems as detailed in AS/NZ 2312 Section 6. These systems performance are dictated by the service environment, both Macro and Micro. This produces the 'life cycle' of the coating system, the expected service life to first maintenance.

Coating types vary greatly depending on location and service conditions also.

New systems are constantly being introduced, both for new construction and for maintenance.

AS/NZ 2312 is the major reference as to expected performance.

Table 5.3 Theoretical v Actual coating performance



6. COATING INTEGRITY EVALUATION

6.1 Defect Evaluation

The coating on the external surfaces of items is visually inspected for coating and substrate degradation such as corrosion pits, rust, blisters, etc. The evaluation is made for each component using the following parameters, irrespective of the extent of coating failure or corrosion damage.

NOTE: Items with minimal or no damage should also be recorded to allow tracking of coating performance.

6.2 Extent of Coating Breakdown (ECB)

The extent of coating breakdown is expressed as a percentage of the area of corrosion observed on the item. This is shown in Table 6 below.

6.3 Corrosion Percentage Charts (CPC)

The corrosion percentage charts give a visual indication as per AS 2312 as observed on item in relation to its area. This is shown in Table 6.1.

Table 6 – Extent of Coating Breakdown

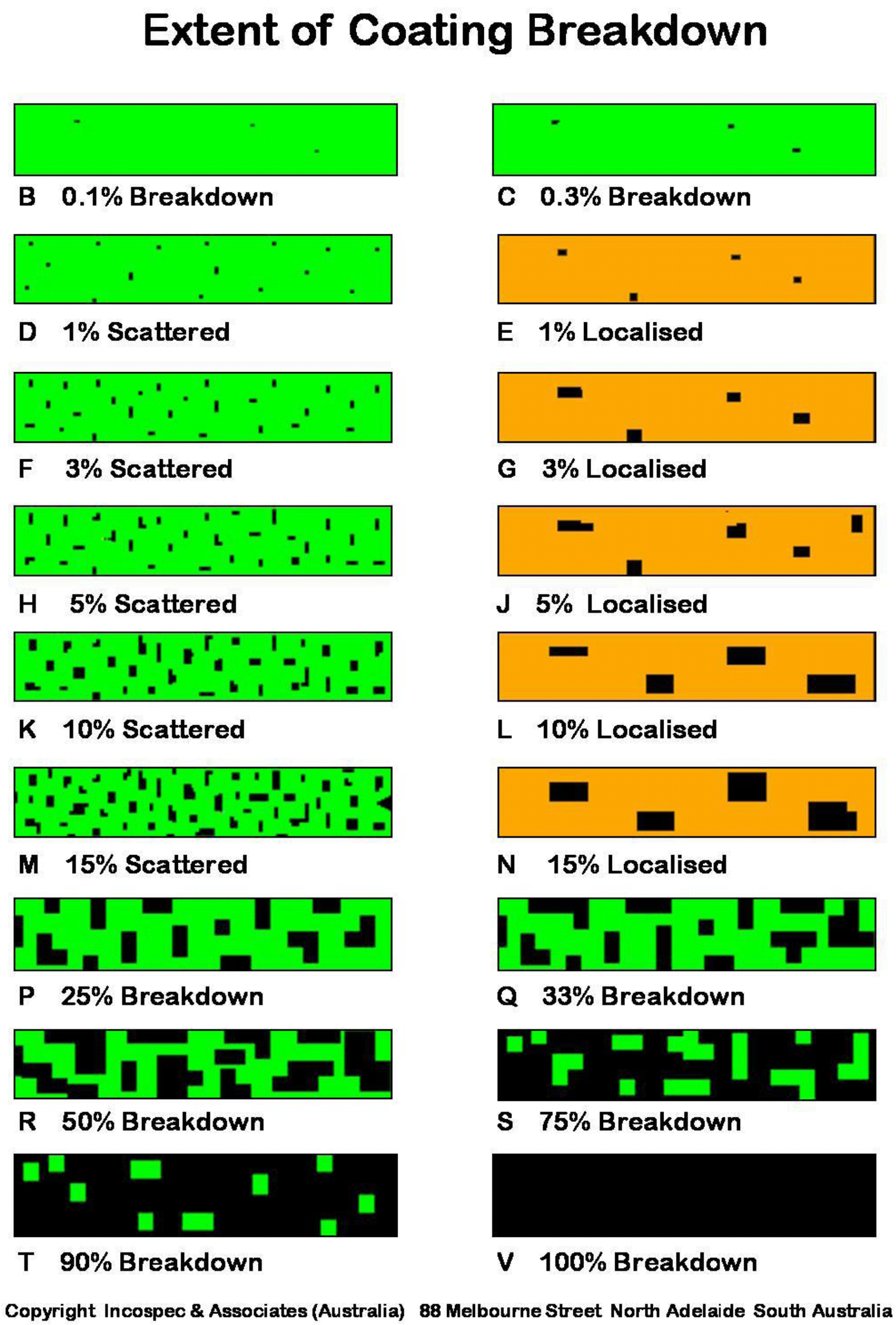
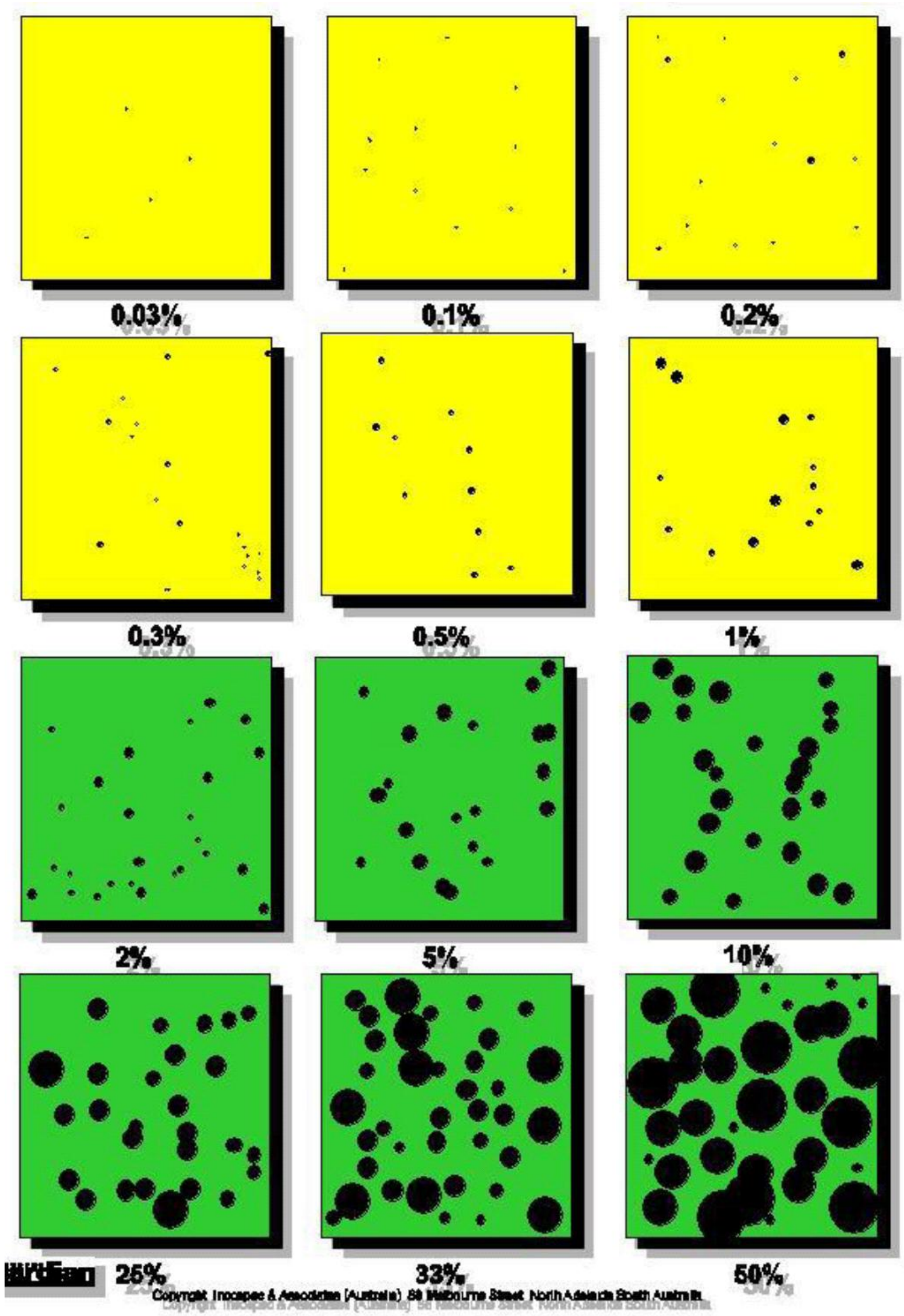


Table 6.1 – Corrosion Percentage Chart



6.4 Corrosion Mode

The corrosion mode is evaluated using the visual guide and descriptors as shown in Table 1.6.

Table 6.3 – Corrosion Modes

General Surface (1) | Blisters (6) | Pinpoint (3)

Cauliflower Fasteners (7) | Edge (8) | Severe Pitting (> 2mm) (9)

Weld Corrosion (10) | Laminar (11) | Oyster Shell (12)

7. DELIVERABLES

Now we have all a current coating condition database which gives us a baseline from which to structure our maintenance plans for short, medium and long term.

For a system to be deemed to be beneficial to the Asset Manager, it should be able to prioritise maintenance painting projects, produce work packs and tender sheets, detailing protective coating systems, surface preparation, surface area, spot touch up or complete recoat of item(s) if required.

High level management review data and charts can be produced to facilitate the justification of funds and acceptance of budget proposals. Examples of this type deliverable information is shown below in Tables 7 7.1 and 7.2.

Reporting suites produced by the system are critical to the Asset Manager’s ability to identify high priority repairs and hot spots, estimated cost of said repairs, potential safety items, Health of plant, risk management plus work pack and scope requirements

An example of one of these reports is shown in Table 7.1 below.

All of this detail will assist the asset manager to maintain his plant in a ‘fit-for-purpose’ condition.

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Table 7 - Work requirement areas Vs percentage of total area.

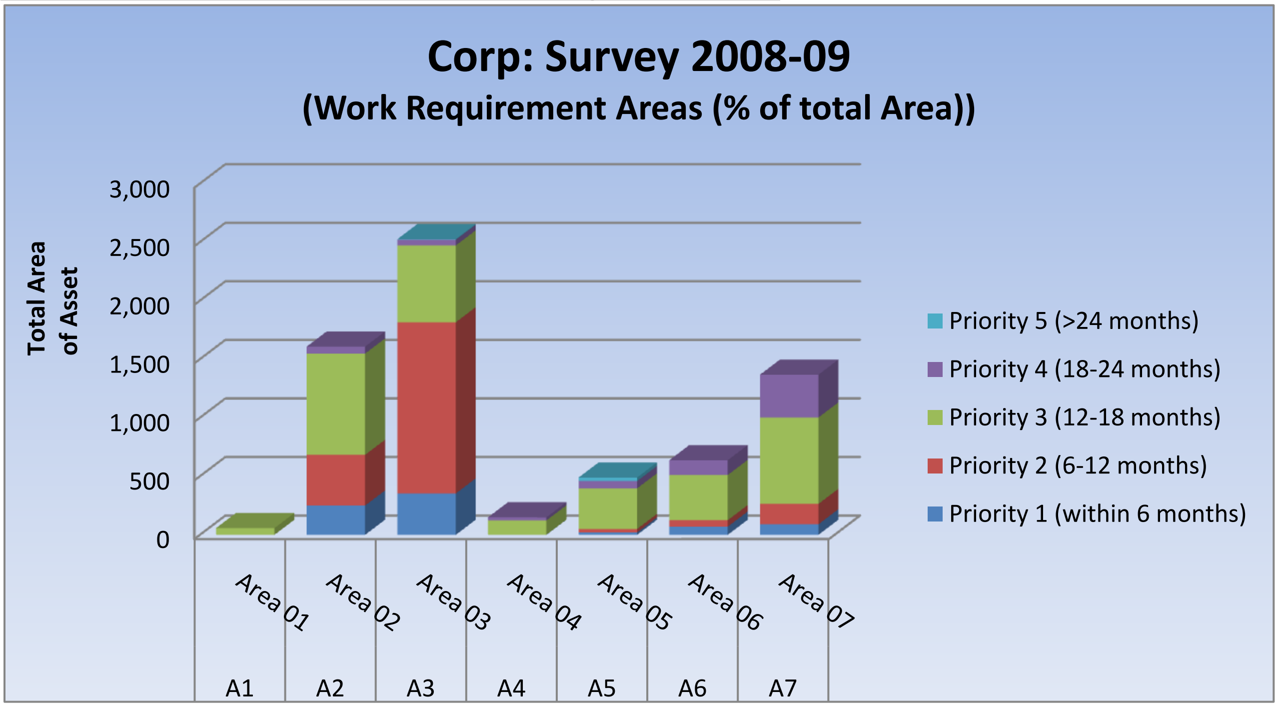


Table 7.1 – Surface areas of plant areas protected by protective coatings

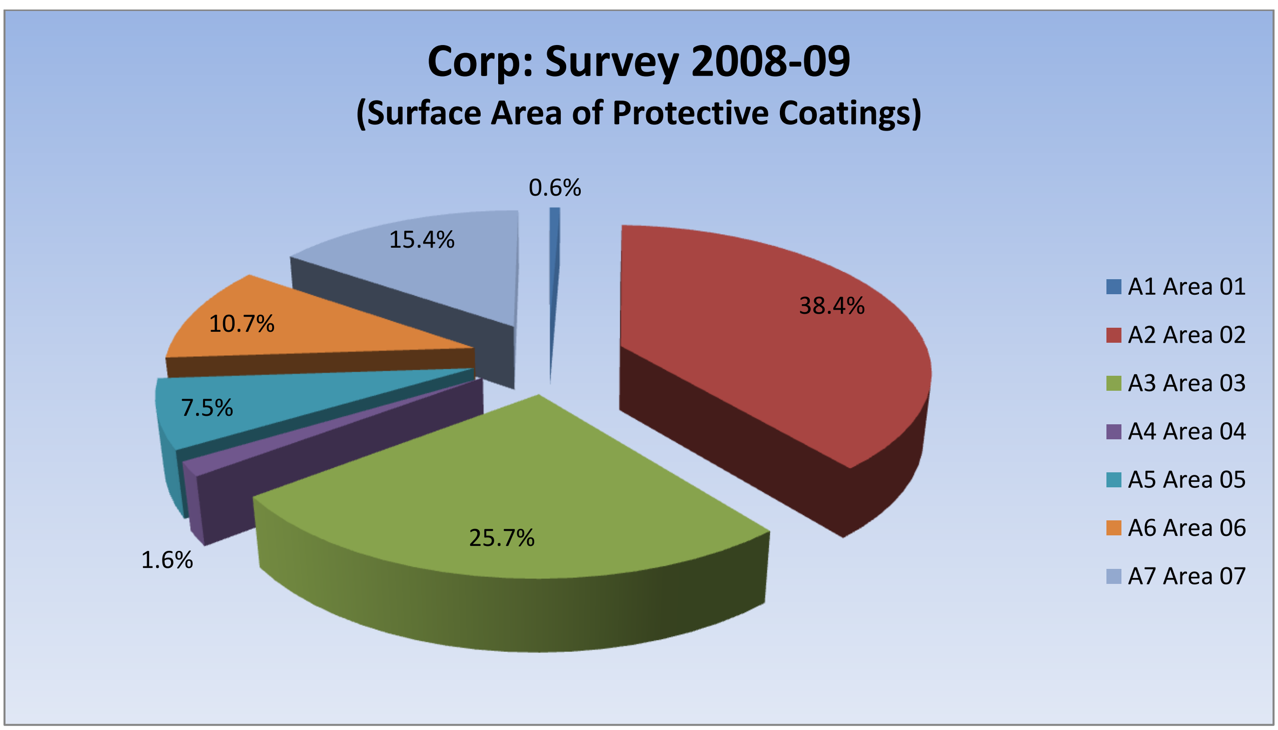


Table 7.2 – Priority 1 & 2 items V estimated cost of repair

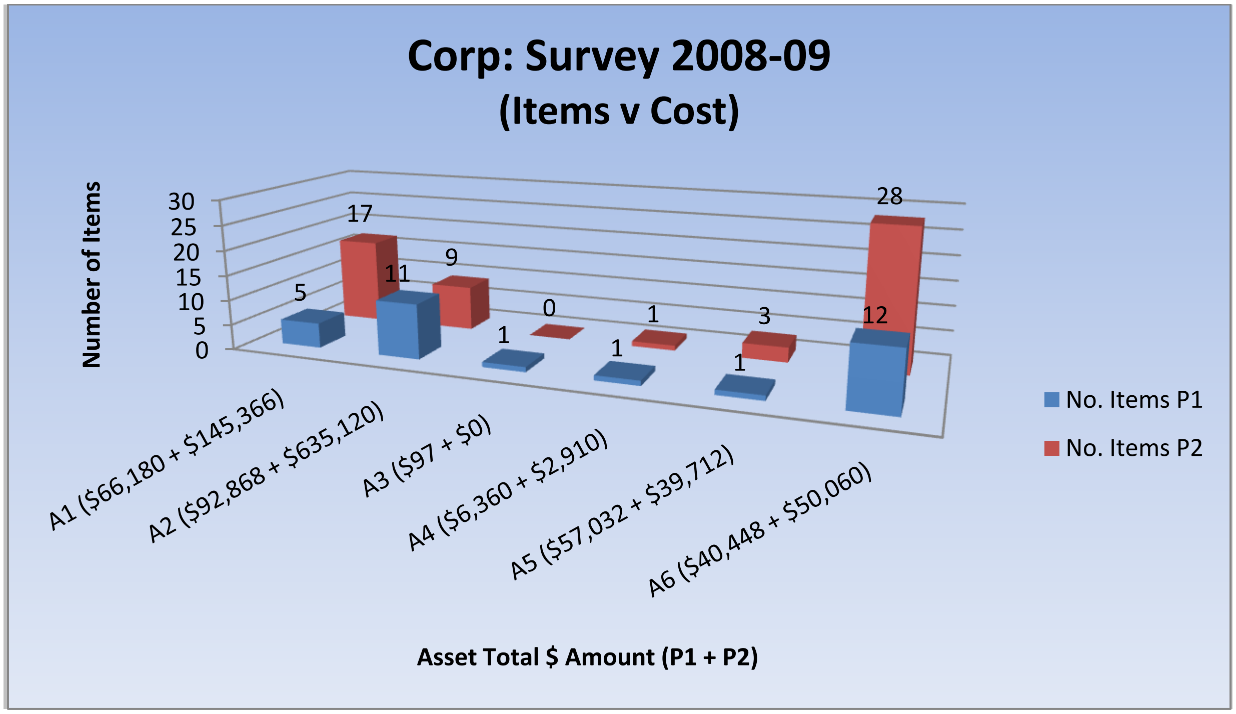
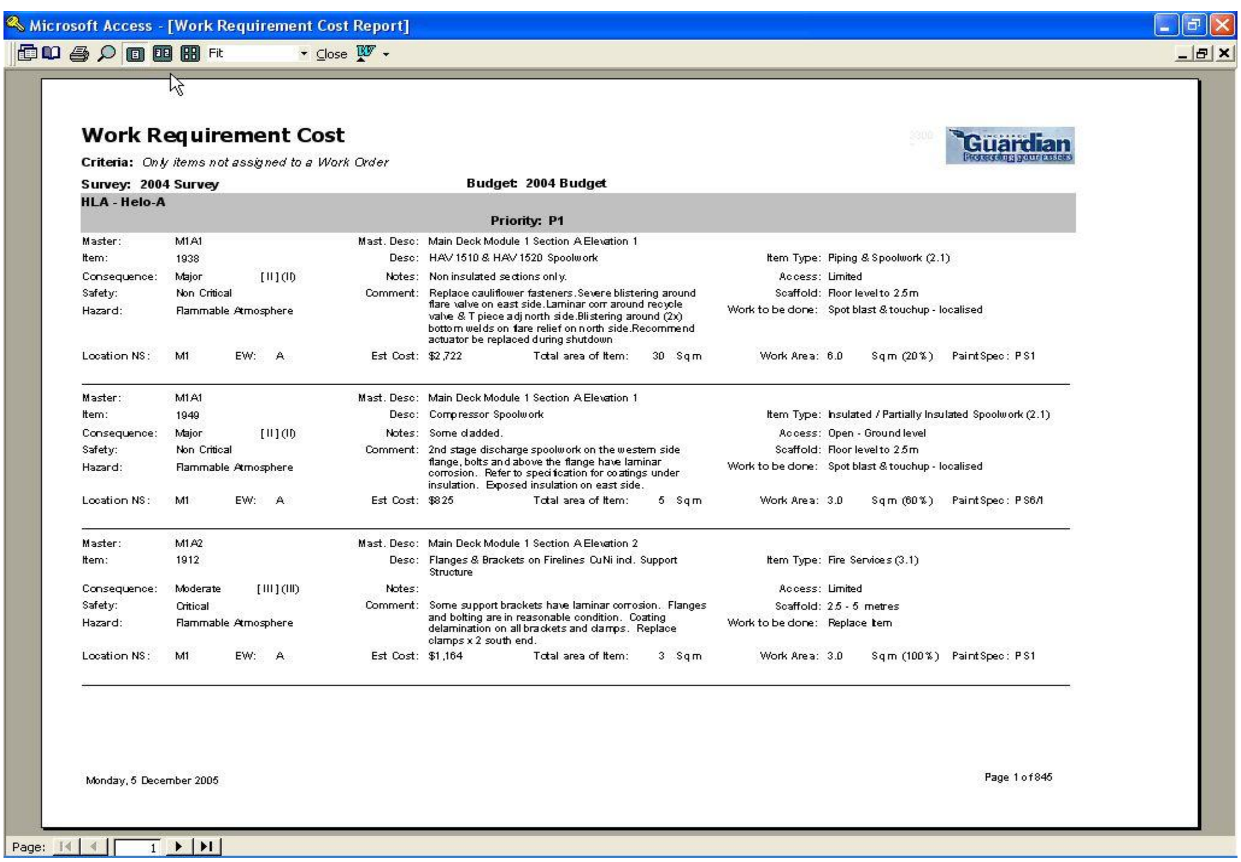


Table 7.3 – Work Requirement Cost Report



Microsoft Access - [Work Requirement Cost Report]

Work Requirement Cost

Criteria: *Only items not assigned to a Work Order*

Survey: 2004 Survey **Budget: 2004 Budget**

HLA - Helo-A

Priority: P1

Master: M1A1	Mast. Desc: Main Deck Module 1 Section A Elevation 1		
Item: 1938	Desc: HAV 1510 & HAV 1520 Spoolwork		Item Type: Piping & Spoolwork (2.1)
Consequence: Major [II] (II)	Notes: Non insulated sections only.		Access: Limited
Safety: Non Critical	Comment: Replace cauliflower fasteners. Severe blistering around flare valve on east side. Laminar corr around recycle valve & T piece adj north side. Blistering around (2x) bottom welds on flare relief on north side. Recommend actuator be replaced during shutdown		Scaffold: Floor level to 2.5m
Hazard: Flammable Atmosphere			Work to be done: Spot blast & touchup - localised
Location NS: M1 EW: A	Est Cost: $2,722	Total area of Item: 30 Sqm	Work Area: 6.0 Sqm (20%) Paint Spec: PS1
Master: M1A1	Mast. Desc: Main Deck Module 1 Section A Elevation 1		
Item: 1949	Desc: Compressor Spoolwork		Item Type: Insulated / Partially Insulated Spoolwork (2.1)
Consequence: Major [II] (II)	Notes: Some cladded.		Access: Open - Ground level
Safety: Non Critical	Comment: 2nd stage discharge spoolwork on the western side flange, bolts and above the flange have laminar corrosion. Refer to specification for coatings under insulation. Exposed insulation on east side.		Scaffold: Floor level to 2.5m
Hazard: Flammable Atmosphere			Work to be done: Spot blast & touchup - localised
Location NS: M1 EW: A	Est Cost: $825	Total area of Item: 5 Sqm	Work Area: 3.0 Sqm (60%) Paint Spec: PS6/1
Master: M1A2	Mast. Desc: Main Deck Module 1 Section A Elevation 2		
Item: 1912	Desc: Flanges & Brackets on Firelines CuNi incl. Support Structure		Item Type: Fire Services (3.1)
Consequence: Moderate [III] (III)	Notes:		Access: Limited
Safety: Critical	Comment: Some support brackets have laminar corrosion. Flanges and bolting are in reasonable condition. Coating delamination on all brackets and clamps. Replace clamps x 2 south end.		Scaffold: 2.5 - 5 metres
Hazard: Flammable Atmosphere			Work to be done: Replace Item
Location NS: M1 EW: A	Est Cost: $1,164	Total area of Item: 3 Sqm	Work Area: 3.0 Sqm (100%) Paint Spec: PS1

Monday, 5 December 2005

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8. CONCLUSION

The Asset Manager is now provided with the ‘tools’ to prepare his maintenance plan.

Knowledge is Power.

He now has the information to justify requests for valuable maintenance funds.

He can now schedule maintenance works in a proactive, disciplined manner ensuring that the asset is maintained as a whole, rather than reactive, undisciplined maintenance, possibly to areas that are not the most needy.

Decisions made on inspectors priorities, calculated Performance Index Numbers (PIN) or on risk can then be made. This process is invaluable to ensure that the most ‘needy’ areas are maintained first, rather than the obvious and aesthetically desirable.

The relationship between coating material performance and proper application is well understood.

Time to first maintenance periods of up to 20 years in a severe environment are possible with the correct choice of properly applied coating. However, these same materials will fail prematurely if not properly applied. Painting contractors may be ultimately responsible for the quality of the applied coatings. However, from the painting contractor’s viewpoint, there is an obvious relationship between the necessity of achieving specified standards and the desirability of minimising costs. Good quality work costs more than poor quality work.

The most effective way to monitor this situation is to appoint highly trained & knowledgeable third party inspectors, accredited and certified by a local and internationally recognised certification scheme.

This will ensure that protective coating systems are applied at an optimal level.

About The Author

Alex is the National Sales & Marketing Manager for Incospec. He also undertakes the role of Operations Manager for our South Australian based projects. Alex joined Incospec in July 2008.

Alex's background has been in Sales and Sales Management positions in both the Telecommunications and Retail industries for the past 15 years.

He has spent time working on both offshore platforms and onshore oil & gas refining facilities around Australia conducting coating and corrosion condition surveys. He has also taken the leading project management role for the various services Incospec & Associates are providing within Australia.

Alex is a NACE Level 2 Coating Inspector and the current Secretary for the Australasian Corrosion Association (ACA) SA Branch. He is also on the organising sub-committee for this year's National ACA conference.

Acknowledgements

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References

- AS 2312 – Schematic diagrammatic examples for estimating rust percentages.
- ASTM D610 – Standard method for evaluating degree of rusting on painted steel surfaces.
- Incospec's Guardian ™ Pictorial of corrosion types.
- Incospec's Guardian™ Extent of Coating Breakdown (ECB) pictorial standard
- National Association of Corrosion Engineers Coating Inspectors Program Level 1 (NACE CIP Level 1) or equivalent inspector.
- Incospec's Guardian™ Survey procedure 'blue book'.