Specification for
Covers of Underground Structures
AM 2757

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Document History

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1. INTRODUCTION

1.1. Purpose of Specification

The purpose of this specification is to document the requirements of covers for underground structures.

Through adoption of this documented standard, SEW is looking to optimise the following:

- Cost of construction
- Prevention of falls (to workers and members of the public)
- Ergonomics of people accessing items of equipment in underground structures
- Visual and traffic considerations
- Structural considerations
- Odour considerations
- Life expectancy considerations (ie: UV, chem resistance etc)
- Considerations and preparedness for whole of life condition assessment

1.2. Scope of Specification

This specification is to apply to all water and sewerage underground structures which contain mechanical and / or electrical items at or near atmospheric temperature. It is relevant to underground structures which require regular access, whether the structures be located under a building or outdoors.

It is to be applied to all new underground structures and any underground structures which are being upgraded.

It is not appropriate for:

- Rarely opened structures such as Sewage Maintenance Holes. Covers for these structures are covered by MRWA-S-313
- Openings which are not horizontal
- Very large openings (ie: openings > 20m²)
- Openings over high temperature, high / low pressure or particularly corrosive gases
- Openings which are not at ground level (eg: elevated covers or tank side access covers).

Where prefabricated structures come with their own proprietary cover system, approval will be required from SEW to use the proprietary cover system unless it meets the requirements of this specification.

This specification does not include detailed designs. Each situation is unique, and each cover system needs to be designed specifically for each site.

1.3. Key References

The following key references provide further information relevant to this specification:

- MRWA Products Portal (SEW products listing)
1.4. Cover Types and Selection

South East Water has four design options for underground structure covers, which include:

1) Aluminium covers
2) Ductile iron covers, and
3) Turret top covers
4) FRP covers (these are not typically used except in treatment plants)

The optimum cover system to be installed shall be determined by South East Water’s design team in consideration of this specification and in consultation stakeholders. This decision can be made only after the local environment and risks can be assessed in accordance with Appendix A, which is usually after the designer has confirmed the future location of the asset. The main issues to consider include:

- life cycle cost and projected asset life
- maintenance and community risks associated with the structure
- the risk of fugitive emissions from the structure
- the location of the structure relative to features in the neighbouring environment

Once South East Water has made its’ decision, the designer is responsible for the detailed design of the cover system in consideration of the requirements specified below.

2. ALUMINIUM COVERS

Aluminium covers are a relatively economic option in non-trafficable, low odour situations. They do not provide for ergonomic access to below ground mechanical and electrical equipment. Refer to Attachment B (sheet 1) for details of this cover system.

Aluminium covers shall be:

- Used only where there is a low risk of odour impacts. Aluminium covers may warp during fabrication, warp during their operational life and the rubber seals tend to compress over time, creating gaps in the cover joins from which odours can escape. This makes aluminium covers inappropriate for structures which contain odour that may negatively affect customers.
- Non-trafficable. They shall only be used inside a building or within an area protected from traffic.
- Usually the best option within buildings, unless odour gases leaking from the underground chamber into the building may be a risk.
- Located at, or slightly above ground level
- Used in conjunction with permanent guardrails.
- Hinged and lightweight such that one person can lift the cover (ie: < 25 kg each).
- Designed to ensure that they will in no way clash or obstruct nearby structures or items when the covers are opened and closed. This can often be a problem if aluminium covers are located adjacent to a turret top cover system.
- Locked (as per the SEW’s Facility Security requirements) when located outside to prevent unauthorised access.
- Designed to ensure that there is no more than a 5mm deflection when a 1 kN (100 kg) is placed anywhere on the covers.
- All handles and locks should be recessed below cover level so they do not sit proud and cause a potential tripping hazard.
• Designed to ensure that when they are open, they **don’t present a trip hazard** or limit access to any nearby items. Normally, permanent guardrails limit the degree to which covers can present a tripping hazard.

• **Restraint in the open position** using a quick catch / release mechanism (eg: SS wire and carabineer or galvanised steel welded link chain) which enables covers to be easily attached to the permanent guardrails. This mechanism shall be sufficiently sturdy that strong winds and large horizontal forces on the cover will not cause the restraint to fail.

• Designed to ensure that they are as **easy and ergonomic to open** and close as possible.

• Provided with **lifting chains**, constructed of minimum 2mm thick welded link chain, fixed to the outer edge of the cover and tied off on the permanent guardrail opposite.

• Inclusive of fall-from-heights protection as described below.

**Fall protection associated with Aluminium Covers (SPS valve pits excepted)** shall:

• Be provided when the underground structure is deep (ie: > 1.5m).

• Comply with the requirements indicated in Figure 1.

• Include the provision of **permanent guardrails** which shall:
  1. complies with AS 1657 (fixed platforms, walkways, stairways and ladders) where practical.
  2. constructed of galvanised steel to AS/NZS 4680 and AS 2309 or grade 316 stainless steel.
  3. Include >100mm high kick plates at ground level.
  4. Have a latched hinged gate to provide access through the guardrail to any internal ladder within the structure. This gate shall swing outwards and be spring loaded to automatically return to the closed position after use. Gates shall be between 600 and 750mm wide.
  5. Have posts securely fastened to the cover slap, each with 4 fasteners as per MRWA sewerage standard figures 314-F or 314-G.

• Include the provision of a **sleeve** (Miller flush mount model DH-20ZP) to be included in the cover slab to enable the insertion of a **davit arm** for person entry fall protection.

• Temporary guardrail arrangements and under cover grating (refer section on ductile iron covers) may be acceptable where permanent guardrails will adversely impact on the functionality of the site.

• Provide a means to attach / restrain open aluminium covers to the guardrail system.
Figure 1: Set up of Aluminium Covers with Fall Protection
(refer Appendix B for details)

Figure 2: Example of aluminium covers with permanent guard rails inside a building.
(Note: a ground level standing area in front of the ladder inside the guardrail area shall be provided if practical. Refer Figure 1)
Figure 3: Example of external aluminium covers with permanent guard rails
(Note: a ground level standing area in front of the ladder inside the guardrail area shall be provided if practical. Swing gates to enable person entry inside the guard rail area is also required. Refer Figure 1)

Figure 4: Example of external aluminium covers with fold up guards
(Note: This arrangement would not be acceptable because Aluminium covers require permanent guardrails)
3. DUCTILE IRON COVERS.

Ductile iron covers are not permitted unless the underground structure must be trafficable (Turret Tops are not suitable in such instances). They shall not be used in situations where an under cover support beam is required to support covers, ie: they shall only be used where there is a single line of adjacent covers (which only occurs where underground items of plant are reasonable small). In cases where larger items of plant need to be removed through openings, they must be located in non-trafficable areas and utilise turret top or aluminium covers. Refer to Attachment B (sheet 2) for details.

Ductile iron covers have the following features:
- Provide trafficable covers.
- Secure from unauthorised access. Covers shall require a specific lifting tool to remove.
- Relatively heavy and so difficult for young children to move. (it is acknowledged that this also increases the manual handling risk to workers removing or reinstalling covers).
- Economic in appropriate situations.
- Provide a gas proof seals which is effective in preventing fugitive emissions.
- Reliant on mechanical lifting aids to lift the cross members when multiple row covers are used. For this reason, only single row multi-part cover systems are permitted.
- Awkward to manage when there are many covers. When they are removed, covers need to be stacked or moved to the side in order to maintain access to the structure. They can present a tripping hazard when not stored out of the way.
- Unable to provide ergonomic access to below ground mechanical and electrical equipment, ie: you must bend down to ground level to handle items under the covers.

Ductile iron covers shall be:
- Located at ground level.
- SEW approved products.
- AS 3996 Class D concrete infill covers in trafficable situations.
- AS 3996 Class B solid top covers in non-trafficable situations (ie: private land protected against traffic by bollards or barriers).
- Adequate in total size to cover the entire opening of the underground structure. Depending on the size of the opening, the covers may either be a single part (max 750 x 750) or multipart cover arrangement.
- Tightly nested and greased to eliminate gaps through which odours can escape.
- Ductile iron covers are appropriate in situations where there is a significant odour risk.
- Installed such that there is no vertical displacement > 2mm which may create a tripping hazard.
- Inclusive of fall-from-heights protection as described below.

Fall protection associated with ductile iron covers shall:
- Be provided when the underground structure is deep (ie: > 1.5m).
- Comply with the requirements indicated in Appendix B (sheet 2).
- Include the provision of three (3) items:
  1. Sleeve inserted into (or mounted on) the cover slab for davit arm insertion, and
  2. Sleeves inserted into the cover slab for the insertion of temporary guardrail posts
  3. Under cover hinged grating
• Sleeves for davit arm insertion shall be:
  1. Miller Flush Mount Floor Sleeve, model DH-20ZP (for insertion into the top of new concrete slabs).
  2. Miller Flush Floor Mount Sleeve, model DH-7ZP (for attachment to the top surface of existing concrete slabs). Where these are used, they shall be carefully positioned to avoid becoming a tripping hazard.
  3. >100mm clearance from the side of a ladder (out of the way of the ladder)
  4. As close as possible to the opening but also with at least 75mm edge distance between the sleeve and the opening to maintain adequate structural concrete around the sleeve.

• A temporary guardrail system shall be provided for each opening which shall be:
  1. readily available off the shelf
  2. lightweight, with each element easily liftable by one person (ie: < 10 kg)
  3. compliant to AS 1657 (fixed platforms, walkways, stairways and ladders)
  4. Include ≥100mm high kick plates at ground level.
  5. structurally stiff and strong enough to withstand a number of people falling against the guardrail at the same time.
  6. stored on site within a powder coated cabinet which meets SEW’s electrical cabinet requirements (refer AM2714).
  7. Contain a ground level standing area ≥1m wide in front of the ladder which is inside the guardrail area (for workers connected to the davit arm fall protection system) to enter/exit the ladder.

• Sleeves for temporary guardrail insertion shall:
  1. Be located within 300mm of the opening but also with at least 75mm edge distance between the sleeve and the opening to maintain adequate structural concrete around the sleeve.
  2. Be constructed of 316 Stainless Steel
  3. Be fitted with removable caps
  4. Have an internal diameter compatible with the selected temporary guardrail posts.
  5. Have a depth > 200mm while still enabling the erected guardrail structure to achieve minimum height.

• Undercover hinged grating shall:
  1. Be hinged along the outer edge so that the grating can hinge upwards and out of the way of human entering the structure.
  2. Normally rest in the horizontal closed position against a load bearing positive stop.
  3. Rest in the open position against the cover slab or temporary guardrail, with a 316 stainless steel quick catch / release mechanism (eg: SS wire and carabiner) which enables the grating to be easily restrained in the open position.
  4. Consist of stainless steel (refer SEW stainless steel specification) mesh with bars (flat or round) at 100mm separation in both dimensions.
  5. Be designed to ensure that there is no more than a 5mm deflection when a 1 kN (100 kg) is placed anywhere on the grating.
  6. Not contain any openings / gaps wider than 200mm.
  7. Contain separate non-entry smaller openings above items (eg: junction boxes) that require regular access. A small hinged grate shall be provided to cover this opening, which shall be large enough to easily work on the below item but not large enough for humans to fall through (eg: < 300 diameter).
Figure 5: Ductile Iron Cover and Fall Protection Arrangements (section isometric view) (refer to Appendix B for details)

Figure 6: Example of Multipart trafficable concrete infill ductile iron covers
4. TURRET TOP COVERS.

Turret top covers are the most common type of cover over pump wells. They provide safe, rapid and easy operations and maintenance access to equipment. They are typically used for larger pumps, or situations where odour risks are significant and the pumps are located in a non-trafficable area. Refer to Appendix B (sheet 3) for details.

Turret top covers are:
- A bespoke metal fabrication that mounts the covers at a handrail height above an underground structure cover slab.
- Able to provide solid protection against accidental fall-from-heights and confined space entry risks, even when the covers are fully open.
- Able to prevent fugitive emissions when the rubber seals are maintained and under compression.
- Able to provide ergonomic access to mechanical plant and electrical/instrumentation equipment, which shall be mounted at waist height where practical.
- Expensive relative to aluminium or ductile iron covers.
- Possibly obstructive to driver / rider / pedestrian visibility when located near roads.
- Possibly detrimental to the visual aesthetics of highly public neighbourhoods.

![Figure 7: Example of turret top close up (note: missing rubber door stoppers)](image_url)
5.1 Turret Top Risks and Controls

While turret tops effectively minimise work time, control fall-from-heights, control unintentional Confined Space Entry and various ergonomic and manual handling risks, other risks that need consideration include:

1) Traffic Risks.

When turret tops are located near roadways, they can hinder the visibility of drivers, riders and pedestrians. Such locations can also increase the need to protect the turret top from collisions with bollards or barriers, reducing access to the structure. These risks increase as the proximity and volume of traffic increases. The site layout design can reduce these risks, though in some cases ground level covers may be preferable. Fences, gates and bollards can be used to reduce the risk of collision.

Figure 8: Example of turret top opened-up (next to aluminium covers opened-up)

Figure 9: Turret Top Arrangements (isometric view)
(refer to Appendix B for details)
2) **Local aesthetic and community acceptance issues.**
Turret tops may create aesthetic issues when located in or near high profile public land. Stakeholder consultation may be required to determine if there are any special requirements. In sensitive areas, the site layout design may be able to address such issues or the turret top may need to be painted in a particular way. Failing that, ground level covers may need to be utilized.

3) **Overhead cables.**
As a crane is required to lift heavy items, such as pumps, over the turret top wall, clearance to overhead cables can be problematic. The designer needs to measure heights to overhead cables, consider electrical no go zones and crane boom heights and then calculate whether items can be safely removed with a turret top in place. If items cannot be safely lifted, ground level covers may be a viable alternative.

4) **Reduction in work space during opening of the covers.**
Turret top covers need to be able to rotate through almost 270 degrees whilst still providing adequate space for workers to stand nearby as this occurs.

### 5.1 General Requirements

Turret tops shall be designed and manufactured:

- To prevent unintentional or unauthorised access to underground structures.
- To enable easy access to all mechanical and electrical items in the underground structure for maintenance activities.
- In a factory environment as much as practical.
- Such that all visible sheet metal / plate surfaces are powder coated 300 micron thick to colour Colourbond Pale Eucalyptus.
- Such that all coatings are applied in a factory environment where practical. Coating damage which occurs during transport or installation shall be checked as part of the ITP (Inspection and Test Plan) and reported to SEW once detected. Only minor coating damage (ie: < 5cm²) may be repaired on site.
- With folded seams / joins as much as practical. Remaining seams / joins shall be welded where practical unless the item needs to be removable, in which case fasteners may be used.
- Such that externally accessible fasteners are tamper proof.
- Such that stainless steel components comply with South East Water’s stainless steel specification.

### 5.1 Floor Mounting Requirements

Turret top floor mountings shall:

- Closely matches the opening of the top slab (0 to +20mm larger than the opening in either dimension).
- Mount entirely on the top surface slab of the underground structure.
- Have a contact surface between the turret top and top slab which is 40 to 75mm wide.
- Be fastened to the top slab with removable min M10 stainless steel fasteners spaced at less than 600mm centres. Fasteners shall be removable from directly above (i.e.: not located within a recess.
- Include a min 5mm thick and ≥40mm wide butyl mastic seal applied around the entire interface between the turret top and top slab (with no gaps to provide a gas seal).
- Be constructed from min 3mm thick stainless steel sheet.
- Be welded to or folded from the turret top wall.

### 5.1 Wall Requirements

Turret top walls shall:

- Be between 1000mm and 1100mm high, noting that the height of the wall needs to be sufficient to enable the covers to hang nearly vertical in the open position.
- Be constructed from min 3mm thick stainless steel sheet.
- Be stiff enough to ensure that a horizontal 1 kN point load applied anywhere on the wall causes less than a 5mm deflection.
- Be stiff enough to ensure that where ladders are fixed to walls, a 100kg person climbing anywhere on any ladder will cause less than a 5mm deflection anywhere on the wall.
- Support all guiderails and be stiff enough to ensure that the positioning of both pumps anywhere along the guiderails will cause less than a 5mm deflection anywhere on the wall.

### 5.1 Cover Requirements

Turret top covers shall:

- Be able to be easily opened by hand (without a mechanical lifting aid) while standing on the top surface of the underground structure.
- Have sufficient open space around the covers such that the covers can be fully opened without interfering with workers standing adjacent to the covers. Workers should be provided with a minimum of 1000mm paved standing room between an opening cover and any nearby obstruction.
- Be constructed from minimum 3mm thick marine grade (grade 5052, 5083 or 6064-T4) aluminium sheet.
- Each weigh less than 20 kg each. Where cover openings are large and cover weights excessive, roll on – roll off covers are an alternative to hinged covers. Lifting bars may also fitted to swing covers to reduce the effort required to move them.
- Be stiff enough to ensure that a vertical 1 kN point (100 kg) load applied anywhere on a cover causes less than a 5mm deflection (relative to the perimeter of the cover, ie: excluding seal compression. Test would involve placing a 100kg weight anywhere on the cover, holding a straight edge across the cover and measuring the max deflection).
- When fully open, rest against rubber stops fitted to the turret top walls. To avoid metal or coating damage, open covers shall not contact the coated sheet metal wall surface.
- When open, swing covers shall hang in a near vertical alignment (i.e. nearly parallel to the turret walls, approximately 270 degree swing) to enable workers to reach over the covers to access items inside the turret top.
Each be fitted with at least one lifting handle near each cover’s edge which is easily accessible while standing on the underground structure’s cover slab.

Have a closing mechanism which has a lever action that ensures adequate compression of the seal. Closing mechanisms fitted to covers should be lightweight to reduce the overall weight of covers.

Have a closing mechanism which can be secured with padlocks, shielded to prevent bolt cutter removal. Padlocks shall be keyed to SEW’s standard and be provided by SEW as per SEW’s lock standards.

Have heavy duty stainless steel hinges with hinge pinion > 6mm in diameter.

Have hinges with a maximum 1500mm separation.

5.1 Cover Seals

Cover seals shall:

- Provide a gas tight seal with turret top walls. The gas seal shall be sufficient that when a piece of tissue paper is held near the seal during any normal operation of the site on a windless day, it will not noticeably flutter.
- Be non-perishable and proven to be resistant to a high hydrogen sulphide environment i.e.: constructed from EPDM or Neoprene.
- Be resilient and continue to provide an effective compressed seal under continual closure for at least 10 years.
- Have seals that neatly match the entire surface to which they mate.

5.1 Confined Space Access Requirements

- All ladders and associated stanchions, brackets and fasteners shall be constructed of stainless steel.
- Ladders (stanchions excepted) shall comply where possible with the requirements of standard drawing SEWL-STD-005 in SEW Supplementary Manual to WSA04 Sewage Pumping Station Code.
- External ladders shall be fixed entirely to the turret top wall with at least 4 points of contact.
- External ladders shall be located shall rest on the top surface cover slab of the underground structure.
- All ground surface within 1000mm of the external ladder shall be included in the cover slab of the underground structure.
- All ladders shall have extendable stanchions to minimum 1.1m above the top rung of the ladder.
- Stanchions shall be able to be raised safely from ground level.
- Inner ladders shall be located to enable safe unimpeded access to the floor of the underground structure in a single vertical pitch.
- A minimum 5mm thick marine grade aluminium or stainless steel swing-away platform shall be provided for traversing between the inner and outer ladders. This platform shall be as long as the gap between the two ladders and as wide as the internal with of the internal and external ladders. This platform shall be connected to the internal ladder ad rotate away from the external ladder (to enable the cover to close). This platform shall drain, i.e. not fill or hold with water in any position.
5.1 Internal Fitout Requirements

- Pump and mixer guiderails shall be extended to within 100mm of the top of the turret top wall.
- Where internal bracing or beams are required (to stiffen the structure &/or provide support for covers), pumps shall be able to be removed without removing any cross beams.
- Internal bracing or beams shall be easily removed when required for general maintenance.
- Flat bar / sheet shall extend internally on all four sides for hanging junction boxes, pump chains, cable socks and mounting pump guiderail brackets.
- This flat bar / sheet shall be minimum 3mm thick, 70mm wide, fabricated from stainless steel with the top of the flat bar / sheet located at 100mm to 200m from the top of the turret wall.

Sufficient cable shall be fitted to all hanging equipment to enable the equipment to be removed and relocated to ground level (for maintenance).

5.1 Turret Top Approved Suppliers

Turret tops may be purchased from one of the following suppliers:


Both of these suppliers have constructed a number of these structures and are aware of SEW’s requirements. Standard drawings are not available for turret tops due to the need for local and site specific variations.

5. ASSET INFORMATION AND REGISTRATION

Installed covers must have clearly marked identification labels with South East Water registered asset identification numbers and descriptions. The covers must be registered into the South East Water asset register with the relevant asset attributes entered. Attributes shall include at least:

- Location (plant area)
- Size (L x W)
- Material (Aluminium, Stainless Steel, Ductile Iron, Fibre Reinforced Polymer)
- Estimated Weight
- Structure being covered (eg: wet well, valve pit)
- Recommended Means of Lifting (eg: crane lift, 1 person lift, 2 person lift)
- Photographic documentation of the installed covers
5.1 Fibre Reinforced Polymer Cover Additional Requirements

The following additional requirements shall be provided for Fibre Reinforced Polymer (FRP) covers:

- Material data information which include but not limited to chemical resistance, physical, mechanical properties and design life
- Standard documentation as set out in WIMES 8.05 Appendix G – FRP/GRP Cover Specification
- Mechanical property information (provided in their commercial standard product sheet, engineering data and/or laboratory test data)
- Flexural strength (MPa) of the cover
- Flexural strength (MPa) of the FRP composite material
- If the FRP cover consist of a finished gel or flow coat, provide the flexural strength (MPa) of the gel, flow coat or external moulded skin
- Additionally retain a spare cover from each manufacturing batch to be held in permanent and safe storage for subsequent testing (including post-contract and long term periods) and comparative investigations. The spares shall be wrapped in plastic bags preventing exposure to sunlight while under storage.
- Sawing or cutting of any manufactured unit or module is not preferred. However in exceptional circumstances if cutting is absolutely necessary, cutting must be done with angle grinders and with compliance to the manufacturer’s requirements. Appropriate gelcoat treatment shall be applied to the exposed surfaces resulting from the cut and shall meet the requirements of the manufacturer.
## 6. APPENDIX A : COVER TYPE SELECTION MATRIX

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<th>Cover Type</th>
<th>Selection Criteria</th>
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<td>Type 1</td>
<td>Priority 1</td>
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<td>Type 2</td>
<td>Priority 2</td>
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<tr>
<td>Type 3</td>
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Notes: 
- Type 1 is selected when priority 1 is the highest.
- Type 2 is selected when priority 2 is the highest and Type 1 is not available.
- Type 3 is selected when priority 3 is the highest and both Type 1 and Type 2 are not available.
<table>
<thead>
<tr>
<th>Cost Factors</th>
<th>Weight</th>
<th>Possible Cost Controls / Issues</th>
<th>Aluminium Covers with permanent guardrails</th>
<th>Score</th>
<th>Data Covers with side level grates and temporary guardrails</th>
<th>Score</th>
<th>Turret Top</th>
<th>Score</th>
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<tbody>
<tr>
<td>Capital costs</td>
<td></td>
<td>Cost of design and construction</td>
<td>Typically $5 to $15k per Underground Chamber</td>
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<td>Typically $5 to $15k per Underground Chamber</td>
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<td>Reduced asset life</td>
<td>Low</td>
<td>Corrosion</td>
<td>Aluminium has a 25 year life.</td>
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<td>Ductile iron has a 25 year life.</td>
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<td>Reduced asset life</td>
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<td>Low corrosion risk materials, AISI levels in Underground Chamber</td>
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<td>AISI (if used) is the most corrosion resistant of material options, although covers are still aluminium</td>
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<td>Reduced asset life</td>
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<td>Location of Underground Chamber and the site’s security (refer to security spec).</td>
<td>Not easily damaged by vandals.</td>
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<td>Not easily damaged by vandals.</td>
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<td>Reduced asset life</td>
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<td>Vehicle Strike</td>
<td>Centred withstand vehicle weight.</td>
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<td>Can support vehicle weight without damage.</td>
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<td>Reduced asset life</td>
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<td>Location of commonly accessed items.</td>
<td>Requires hinges and locks.</td>
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<td>Time &amp; Cost of Maintenance</td>
<td>High</td>
<td>Access to M&amp;E items. Case of inspection. Time to set up safety equipment. Time more can also means more time exposed to CHS risks and some increase in likelihood. Frequency and duration of maintenance.</td>
<td>Lightweight and can be operated by one person. Good set up time, but poor access to M&amp;E items below ground level.</td>
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<td>Covers can get in the way, takes time to get them out from the working area.</td>
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<th>Weight</th>
<th>Possible Risk Controls / Issues</th>
<th>Aluminium Covers with permanent guardrails</th>
<th>Score</th>
<th>Data Covers with side level grates and temporary guardrails</th>
<th>Score</th>
<th>Turret Top</th>
<th>Score</th>
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<tbody>
<tr>
<td>Exposure</td>
<td>High</td>
<td>10</td>
<td>Avoid location - distance to people &amp; number of people exposed.</td>
<td>Very difficult to make gas tight. Pertains to wide public access to site, there is a significant buffer to nearby people or the structure is located under building / enclosure.</td>
<td>3</td>
<td>Effective fall prevention measures can be deployed. Mays have to be removed during equipment removal from the well. Careful design required to reduce tripping risk of covers if lying on ground when open.</td>
<td>4</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Noise</td>
<td>Moderate</td>
<td>8</td>
<td>Location of underground Chamber.</td>
<td>Reduce exposure to the opening (reduce maintenance or elevate opening).</td>
<td>4</td>
<td>Effective fall prevention measures can be deployed. Mays have to be removed during equipment removal from the well. Careful design required to reduce tripping risk of covers if lying on ground when open.</td>
<td>4</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Public Access to Open / pedestrian or vehicle area</td>
<td>Moderate</td>
<td>6</td>
<td>Location - number &amp; proximity of people nearby.</td>
<td>Can be published information requiring specialist tools such as used. Covers may be welded.</td>
<td>4</td>
<td>Very unlikely unless signage and barricades not deployed.</td>
<td>4</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Security</td>
<td>High</td>
<td>10</td>
<td>History of crime / security breaches in the area.</td>
<td>Can be published information requiring specialist tools such as used. Covers may be welded.</td>
<td>4</td>
<td>Can be published. Live barriers requiring specialist tools to remove or weld seams.</td>
<td>4</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Manual handling to open / close covers</td>
<td>Moderate</td>
<td>8</td>
<td>Movement of heavy covers. Awkwardness of cover removal in high traffic areas.</td>
<td>May not a feasible solution in areas where turret top would impede driver / pedestrian visibility in the roadway.</td>
<td>4</td>
<td></td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manual handling to open / close covers</td>
<td>Moderate</td>
<td>8</td>
<td>Movement of heavy covers. Awkwardness of cover removal (reaching up, down or across, sitting).</td>
<td>Can be published. Live barriers requiring specialist tools to remove or weld seams.</td>
<td>4</td>
<td></td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manual handling to open / close covers</td>
<td>Moderate</td>
<td>8</td>
<td>Movement of heavy covers. Awkwardness of cover removal (reaching up, down or across, sitting).</td>
<td>Provided cover size is not excessive, moderate risk, especially as covers can be manually lifted with chains from a good working height.</td>
<td>3</td>
<td>Provided cover size is not excessive, moderate risk as covers are lifted from a good working height.</td>
<td>3</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Cages form an obstruction when open</td>
<td>Low</td>
<td>Location of commonly accessed items.</td>
<td>Cannot withstand vehicle weight.</td>
<td>4</td>
<td>Cannot withstand vehicle weight.</td>
<td>4</td>
<td></td>
<td>4</td>
<td></td>
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<td>Cannot withstand vehicle weight.</td>
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<td></td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>

| WEIGHTED AVERAGE TOTAL |       | 15.8 | 16.7 | 16.7 |

**Underground Chamber Covers - Cost & Risk Assessment**

**PROCESS**

- Score all options the same if the cost / risk issue is not relevant to the project. Score each risk / cost using score 0 to 4 per scoring system above. Some scores are provided but they may be changed.
- The highest rating option has scored a component and is the most feasible, in which case select the next highest feasible option.

**Risk Descriptions**

- Low cost / risk: Slight
- Medium cost / risk: Moderate
- High cost / risk: High

**Risk Factors**

- Effectiveness Slight / Cost Risk Level
- Weight
- Possible Risk Controls / Issues
- Aluminium Covers with permanent guardrails
- Score
- Data Covers with side level grates and temporary guardrails
- Score
- Turret Top
- Score
7. APPENDIX B : COVER DESIGN ILLUSTRATIONS
FIGURE A: ALUMINIUM COVER SYSTEM - ISOMETRIC VIEW

TABLE A: COMPONENTS

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>MATERIAL</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>A COVER SLAB</td>
<td>galvanized steel or SS</td>
<td>opens to suit underground plant</td>
</tr>
<tr>
<td>B LADDER</td>
<td>SS 193</td>
<td>to include roof plates, to AS 1657</td>
</tr>
<tr>
<td>C DAVIT ARM MOUNTING</td>
<td>SS 304</td>
<td>Miller flush mount, SS 304 model DH 2035</td>
</tr>
<tr>
<td>D ALUMINIUM COVER, 1ST OPEN</td>
<td>marine grade aluminium</td>
<td>each cover to have recessed handle, When Open, Do not present tripping hazard. 1ST COVER OPEN IS TO LATCH TO COVER SLAB AND LOCK WITH STANDARD SEW LOCK. 2ND COVER TO BE HELD DOWN BY 1ST COVER. 3RD COVER BY 2ND COVER &amp; SO ONLY ONE LOCK REQUIRED</td>
</tr>
<tr>
<td>E ALUMINIUM COVER, 2ND OPEN</td>
<td>marine grade aluminium</td>
<td>Enables covers to be lifted from a standing position</td>
</tr>
<tr>
<td>F ALUMINIUM COVER, 3RD OPEN</td>
<td>marine grade aluminium</td>
<td>Enables covers to be lifted from a standing position</td>
</tr>
<tr>
<td>G LIFTING CHAIN</td>
<td>galvanized welded link chain with links; 200 mm thick, carabiner to clip through links</td>
<td>to restrain end of cover and end off at top of vertical post of guardrail on the opposite side</td>
</tr>
<tr>
<td>H COVER RESTRAINTS</td>
<td>carabiner with short SS 316 leash to top of vertical guardrail post</td>
<td>carabiner through a lifting chain link</td>
</tr>
</tbody>
</table>

Notes Regarding Aluminium Covers:
1. This drawing is indicative only, and does not represent a fabrication or construction issue drawing.
2. Each cover system needs to be individually designed to suit the requirements of the site and to enable safe and efficient operations and maintenance activities to be performed.
3. These covers are non-trafficable and shall only be used in conjunction with appropriate measures to prevent vehicle traffic on the covers.
4. These covers shall only be used in conjunction with permanent guardrails.
5. These covers shall only be used where odour emissions are unlikely to be problematic.
6. All dimensions in mm.

FIGURE B: ALUMINIUM COVER SYSTEM - PLAN VIEW

TABLE A: COMPONENTS

<table>
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</tr>
<tr>
<td>H COVER RESTRAINTS</td>
<td>carabiner with short SS 316 leash to top of vertical guardrail post</td>
<td>carabiner through a lifting chain link</td>
</tr>
</tbody>
</table>
Notes Regarding Ductile Iron Covers:

1. This drawing is indicative only, and does not represent a fabrication or construction issue drawing.
2. Each cover system needs to be individually designed so that it integrates well with the other assets on site and enables safe and efficient operations and maintenance activities to be performed.
3. These covers are for structures in trafficable areas.
4. These covers shall only be used in conjunction with temporary mobile guardrails.
5. All dimensions are in mm.
ROLL ON - ROLL OFF COVERS ARE AN ALTERNATIVE TO SWING COVERS WHERE COVER WEIGHTS ARE EXCESSIVE.

**FIGURE A: TURRET TOP COVER SYSTEM - ISOMETRIC VIEW**

**TABLE A: COMPONENTS**

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>MATERIAL</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>A COVER SLAB</td>
<td>REINFORCED CONCRETE</td>
<td>OPENING SIZED TO SUIT UNDERGROUND PLANT</td>
</tr>
<tr>
<td>B TURRET TOP WALLS</td>
<td>3MM THICK STAINLESS STEEL</td>
<td>TO SEW DRAWING SEWL-STD-005</td>
</tr>
<tr>
<td>C LADDER</td>
<td>SS316L</td>
<td>MILLER PLUSH MOUNT SLEEVE MODEL DH-20SS</td>
</tr>
<tr>
<td>D DAVIT ARM MOUNTING</td>
<td>SS304</td>
<td>MILLER PLUSH MOUNT SLEEVE MODEL DH-20SS</td>
</tr>
<tr>
<td>E ALUMINIUM COVER</td>
<td>MARINE GRADE ALUMINIUM</td>
<td>ROLL OFF - ROLL OFF COVERS ARE AN ALTERNATIVE TO SWING COVERS WHERE COVER WEIGHTS ARE EXCESSIVE</td>
</tr>
<tr>
<td>F PLATFORM</td>
<td>SS316</td>
<td>PROVIDES EDGE OVER WHICH TO HANG CHAINS, INSTRUMENT LINES, JUNCTION BOXES etc</td>
</tr>
<tr>
<td>G HANGING BRACKET</td>
<td>SS316</td>
<td></td>
</tr>
<tr>
<td>H COVER HANDLE</td>
<td>SS316</td>
<td></td>
</tr>
</tbody>
</table>

**Notes Regarding Turret Top Covers:**

1. This drawing is indicative only, and does not represent a fabrication or construction issue drawing.
2. Each cover system needs to be individually designed so that it integrates well with the other assets on site and enables safe and efficient operations and maintenance activities to be performed.

**FIGURE B: TURRET TOP COVER SYSTEM - SECTION VIEW**

**TURRET TOP WALLS**

3MM THICK STAINLESS STEEL

**PLATFORM**

SS316

**REQUIRE AT LEAST 1M WIDE PAVED AREA ALL THE WAY AROUND THE TURRET TOP, ALL AT THE SAME LEVEL**