CONSERVATION SPECIFICATION

KRAUSS TRAM DISPLAY BUILDING
BUDERIM QLD

CLIENT:
SUNSHINE COAST COUNCIL

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1. Introduction

These Conservation Specifications and advice have been put together to guide the Sunshine Coast Council (SCC), the Buderim Palmwoods Tram Heritage Society (BPTHS), Architects, Builders, Exhibition Designers, and other Contractors; and should be taken into consideration when planning the construction of the proposed Krauss Display Building at Buderim, and any future refurbishments. It is important to consider the key conservation criteria at an early stage of the project, so that the safe storage of the Krauss tram and associated objects can be ensured. Conservation recommendations prioritise the preservation of the Krauss Tram and assocaited collection materials to ensure future longevity.

2. Brief Condition Assessment of Krauss Tram

Object	Krauss Tram situated at Wises Farm
Materials of construction	Iron alloy, paint, glass, wood, Perspex, rubber, wood laminate, copper
Dimension	L 6.5786m, W 2m, H 3.2004m
Weight	Weight on arrival from Germany was 23 tonne. Apparently it is now approx. 20 tonne.
Condition	**Summary:** ☐ Good condition ☒ Minor instability or damages ☐ Poor condition ☒ Requires treatment/monitoring **Structural Problems:** ☐ No apparent damage ☐ Loss/chip/hole ☐ Tears ☐ Indentations ☐ Loose components ☐ Punctures ☐ Cracks ☐ Distortions ☒ Infestation ☐ Insect damages ☐ Fungal attack ☐ Other **Surface Problems:** ☐ No apparent damage ☒ Surface dirt ☐ Flaking ☐ Abrasion ☐ Stain/mark/ingrained dirt ☐ Tarnish ☐ Scratch ☐ Loss/chip/hole ☒ Corrosion ☒ Accretions ☐ Pigment/paint loss ☐ Bloom/salt ☐ Friable ☐ Discolouration ☐ Other **Notes:** · Mostly stable condition. · Active corrosion is present beneath the paint film and at joins and edges of metal components. · Dissimilar metals in direct contact are currently stable. · Dust dirt and debris has accumulated as a result of outdoor storage. · wooden peg broken off steering mechanism · splitting to facsimile timber components at wheels as a result of Relative Humidity fluctuation · Track and sleepers display termite and considerable insect, rodent, bird and other pest activity · The tram exhibits fading and chalking of the new paint film.

3. Type of Collection Materials proposed for inclusion in the display building:

The Krauss tram itself will be displayed within the main display structure of the building. There is potential to include other related materials for display if the building footprint is large enough. Alternately, it is possible that small display cases may be recessed into nearby walls to house tram related historical objects. As the display concept has not yet been finalised, a definitive list of items and their display location is yet to be collated. If the Krauss tram is displayed alone in the large display space, this would include the following materials types:

Original fabric:

- Ferrous metals and alloys, wood, rubber, copper

Replica fabric:

- Perspex replica dials
- PVC pipe and fittings replica components
- Vinyl laminate (tram cab roof lining)
- Wood replica components (some splitting and cracking)
- Painted surface – tram - grey undercoat (removed) red oxide paint, acrylic – satin or flat (some chalking to paint film)
- Brass builder's plate replica (painted)
- Brass fittings for copper air pipe connectors at bottom (replica).
- Copper pipe – whistle copy
- MDF and plywood – replica safety valve
- Toughened glass – replica in window frames
- Bituminous anti corrosive paint - inside replica side tanks
- Loctite adhesive – attach rivets to replica side tanks
- Steel and alloy – replica tram panels and pieces, bolts

The following additional tram related Objects could also potentially be displayed within the large display area. Materials types include:

Original Fabric:

- Iron alloy (corroded) - tools, bolts, advertising sign, buffer, plus other large rusty metal on site at Wises farm, Train track (to be excavated and displayed with sleepers)
- Iron Alloy – tram - mostly stable, some surface rust
- Metal – tram oil cans – these have a plated/painted surface and appear to be made of iron alloy, tin alloy, with copper and brass components
- Copper – tram components
- Rubber – tram hose
- Glass - ink bottle, tram

- Ceramic - insulator
- Wood (desiccated condition) – Track sleepers (to be excavated and displayed.) wooden cross bar and ceramic insulator, wooden survey peg, culvert timbers (timber frame used in Culvert /drain– this is large and dug out of the ground!) buffer timber,
- Wood (sound condition) Stokers shovel, hammer and brush – wooden handles, tram timber components
- Bristle - brush
- Painted surface – brush, hammer, advertising sign, tram
- Paper – label on back of advertising sign, map

Possible future assets include:

- Original Forest Glen station building
- Cutlers Desk (wood, varnish, silver plate, brass screws)
- Garth Fraser Models - Unknown modern materials

It must also be kept in mind that new objects not assessed at this stage could potentially be acquired and displayed in this space at a future time. If this is likely, the design of the space should accommodate the possibility of repurposing or displaying sensitive materials in the future.

4. Factors that causes deterioration of Collection Materials

4.1 Light

Light damage is permanent and accumulative, its energy causing damage to materials from the UV, Visible, and Infra-Red parts of the spectrum. UV light (u watt / lumen) is highly energized (at wavelengths 320-380nm) and induces photochemical deterioration. Visible light (380 -760nm) can induce deterioration at the high energy blue end of the spectrum, as well as by heat produced by light at the lower energy red end of the spectrum. The brighter the light is (lux) the more damage the light causes. Visible light can also affect the way the viewer distinguishes an objects colour. Infra-Red light (760nm+) can heat objects, activating processes of chemical deterioration that can cause embrittlement, fading, and discolouration. Heat changes caused by Infra-Red light can also affect RH levels (Gilroy, Godfrey, 1998, p1-2)

Ideal light conditions for items in a museum environment are:

Sensitivity	UV content	Illuminance	Material type
Most sensitive	<30 u watt/lumen	50 lux	Textiles, feathers, animal products including skin and hair, dyed leather, tapestries, prints, drawings, stamps, manuscripts, colour photo prints and transparencies, paintings.
Moderately	<80 u watt/lumen	200 lux	Lacquer ware, wood, furniture, horn, bone, ivory, black and white

Sensitive			photographs, plastics and some minerals
Least sensitive	<200 u watt/lumen	1000 lux (assess effect of radiant heat)	Stone, ceramics , glass and metals

(Thompson, 2002, p36)

Recommendations:

- If the aim is to prolong the lifespan of Krauss restoration coatings, and display sensitive materials within the display space, light levels should be kept below 30 u watt/lumen and illuminance of 50 Lux.
- Light levels should be kept below 200 u watt/lumen and illuminance of 1000 lux if the Krauss paint coating is regarded as sacrificial and sensitive materials are displayed elsewhere.

4.2 Temperature and Relative Humidity

After light damage, RH and Temperature are the most significant factors leading to object deterioration. The main impact of temperature is to increase the rate of cumulative chemical degradation reactions in objects, and to increase RH, as a 10C rise in temperature, will double the rate at which an object will deteriorate (Gilroy, Godfrey, 1988, 5-6). High temperatures also increase the activity of insect pests and the rate of mould growth. Low temperatures are preferable for storage, however temperatures below 13C also need to be avoided as some materials (like acrylics) can undergo phase change and become brittle. (Erhardt, Tumosa, Mecklenburg, 2007, p15).

High RH will initiate metal corrosion, swelling and warping of organic materials, buckling of paper, and softening of adhesives. Low RH will cause embrittlement of paper and textiles, plus desiccation and shrinking of organic materials such as bird skins. “RH is the major issue, as more water becomes available to an object there is more chance of chemical reaction, although any increase in temperature increases the rate of reaction.” (Michalski, 2014, p26). Therefore, RH must be kept at levels where moisture is high enough to maintain flexibility; but also low enough to slow deterioration of materials and to control insects and mould.
“It has been found that organic materials which have naturally acclimatised to a midrange RH of around 50 per cent, a variation in RH on a daily basis of:

- 10 per cent (e.g. 40-60 per cent RH) represents a low risk to most organic materials.
- 20 per cent is dangerous to some composite objects.
- 40 per cent is destructive to most organic objects.”

(Brown, Cole, Daniel, King, Pearson, 2002, p16)

High levels of Temperature and RH fluctuation can place great mechanical stress on collection materials. However, the rate of fluctuation in environmental conditions is not a factor if the object is maintained within the range of 30-60% (Mecklenburg, 2007, p. 73, 74). Outside of this range, frequent temperature fluctuations can cause distortions, and delamination, especially to organic materials. Frequent fluctuations in RH can cause expansion and contraction of the cellular structure, resulting in delamination and buckling of organic materials; or cracking and crushing if the movement of materials is restricted. Collection materials respond quickly (within hours) to temperature changes, and slowly (within weeks or months) to RH changes.

The deterioration of collection materials is caused by different processes. Creating a stable environment relies on finding a balance between the risks and benefits of biological (i.e. mould and pest), chemical (i.e. hydrolysis, crosslinking and oxidation accelerated by temperature and RH), and mechanical deterioration (i.e. dimensional change metrics). (Image Permanence Institute, 2005, p. 37) RH affects the type of reaction, and Temperature affects the rate of the reaction. Hydrolysis reactions dominated at RH levels above 35%, and cross-linking reactions dominated below 30% RH. (Erhardt, Mecklenburg, 1995).

The climate history experienced during use of the Krauss Tram, the proofed fluctuation that it has encountered as part of its lifespan and normal use, plus the nature of the materials that comprise the Krauss tram and associated collection materials should all be taken into account. Regulating the environment in the Krauss display building should prioritise the overall management of extreme environmental conditions, rather than focusing on limiting T and RH to a very narrow range. Maintaining good air circulation is very important, so that pockets of dead air don't form and promote corrosion, the growth of biological agents, mould, and insects.

Recommendations:

- ASHRAE Class A Options 1 and 2 recommends 15-29C and 45-65% RH as appropriate for collections of this nature.

4.3 Pests

A significant threat to the collection is biological agents. The incidence of pest activity increases when RH and temperature is high. Even if general housekeeping is good, there is still certain to be insect activity in an unsealed space. Likely pests include, mud wasps, carpet beetle, wood borer, termites, booklice, moths, cockroaches and spiders. Rats, mice, bats, birds, possums

Recommendations:

- Ongoing IPM Pest monitoring and response.
- Thoroughly clean the Krauss of insect pests and vermin before installation into the display building.
- Seal the building and implement a frequent cleaning policy.
- Food and drink should not be brought into the display area.
- Reduce RH and C to limit climate conditions that encourage pest activity.

- Quarantine and treat objects moving into the building from infested areas. Anoxic or Freezer treatment is suitable for insect eradication.

4.4 Dusts and Pollutants

Pollutants are the other major consideration when looking at environmental conditions. Normal urban air contains many gases such as sulfur dioxide, hydrogen sulfide, nitrogen oxides, and ozone which can be absorbed by artefacts. It is important to have adequate filtering on air handling units and to keep the building closed as much as is possible, so as to minimise the ingress of pollutants from outside. "Ideally, a filtering system for the air is maintained such that 50% of particulates are removed (ASHRAE dust spot efficiency test) and that airflow is such that there are no bad air zones that allow mould and mildew to develop" (Thomson, 1978, p36). To achieve this, "the air filtration system should incorporate activated charcoal filters in addition to the viscous (oil based) impingement filters to remove any acidic or oxidising gasses from the atmosphere." (Pearson, 1997, p10).

Museum objects, building and furnishing materials such as carpets, wood, some textiles, paint coatings, concrete, and plastics also off-gas pollutants. These gases and pollutants can react with the moisture in an object or in the atmosphere to produce acids, causing deterioration. For example they can increase the rate of cellulosic deterioration, can induce metal corrosion, and can cause the weeping of glass and ceramic glazed objects.

Additionally, air contains a lot of particulate matter such as dust, ash, smoke, dirt, and mould spores. This is a significant risk because these particles accumulate on objects in a way that abrades, disfigures, obscures, and accelerates, deterioration of their surfaces. The settling of these particles on objects encourages the increase of acidity and the settling of mould spores.

Of particular concern is the nearby heated and Chlorinated Swimming Pool. The swimming pool is a high humidity and high temperature environment, with pool temperatures kept at 27C and 32C. This produces an aggressively corrosive microclimate in combination with the Chloramines that off gas from the pool surface; plus the salts, acids and other chemicals that are also used in swimming pools.

Recommendations:

- Air-conditioning system has filtering that is capable of removing 50% of particulates.
- Storage and Display areas of the building to be sealed and kept closed as much as possible.
- Air-conditioning system with regular air changes
- Guideline for pollutant limits in display space:
  - Pollutants - less than 5% of outdoors
  - Ozone – trace levels
  - SO2 NO2 less than 10ug/m3
- Filtration system
- Site the building at a distance from, and upwind of the swimming pool.

4.5 Water Ingress and Mould

Mould growth is possible when RH exceeds 65 - 70%. However, "The exact conditions under which, for example, mould will form is dependent on many factors so the 65% RH value is realistic but not restrictive." (Sebera, 1994, p. 5). Mould is likely to be a problem if the space is not climate controlled and remains unsealed. Mould growth is especially encouraged in areas where there are also large quantities of dust and/or limited air circulation. This also presents an OH&S respiratory issue for staff handling mould affected materials.

If not climate controlled by and HVAC system, Temperature and RH will follows the external climate significantly due to poor insulation of the building fabric. Subsequently RH will be high when there are RH rises in the external climate. This presents a mould risk.

If the building is poorly sealed water ingress will occur, during windy wet weather. Significant dust ingress creates nucleating points for mould growth on objects and this exacerbates mould issues.

Recommendations:

- Seal building to prevent humidity and dust ingress.
- Use of dehumidification equipment, or at least mobile dehumidifiers when RH reaches 70% or above
- fans to be switched on when high RH is observed, and preferably at all times of the year to help increase air circulation
- membranes beneath cement slab to prevent rising damp and efflorescence
- Guttering/roof pitch, drainage and landscaping designed to funnel water away from the base of the building
- Exclude garden beds from the base of the building

4.6 Visitor impact

The proposed buildings structure itself is sturdy and there is no likelihood of any severe impact being caused by visitors. There is a risk of breakage to the glass from vandalism, and cleaning of the glass will need to be ongoing.

The tram itself is most prone to visitor impact, particularly if excursions of schoolchildren and other tour groups are taken through the display space. This will impart general wear and tear plus damage, and will compromise the display areas ability to mitigate preventive conservation factors.

Recommendations:

- A railing could be installed at an arm's length distance from the glass to reduce handprints, grime, and the necessity of continuous cleaning.
- Anti-graffiti films should be installed to deter vandalism and glass breakage.
- Limit access to the display space from visitors – preferably visitors should not enter the display.

4.7 Disaster preparedness and Risk Assessment

Disasters can include both external risks and issues inherent in the objects and display itself. A basic Disaster Preparedness Plan should be drawn up, and a formalised hazard and Risk Assessment would be the first step in this process.

A basic plan could identify evacuation priorities "at risk" items, and potential hazards such as sharp edges, restoration chemical residues or potentially dangerous moving parts. Having an "on call" list of organisations that would help with moving collection items at short notice is important.

A fire extinguisher, first aid kit and basic disaster kit should be kept on site, and volunteers familiarized with its use.

Recommendations:

- Risk and Hazard Assessment to be carried out followed by a basic Disaster Preparedness Plan using the "Be Prepared" guidelines.

5. Preventive Conservation Requirements for Material Types Present in the Krauss Tram and Collection

Different classes of materials have different Preventive Conservation requirements. Not all materials types are suitable for display in the same environmental conditions. Different micro climates could potentially be created in the main display area compared to the smaller display cases, so as to suit different or more sensitive materials types. Particularly sensitive materials should not be displayed at the proposed location.

Recommendations:

Sensitive materials should be stored elsewhere in tightly controlled climate conditions of 18-22C, 45-55% RH, UV content below 30 u watt/lumen, and illuminance below 50 lux. This includes:

- Paper map (a replica image could be displayed)
- Paper label on the back of painted sign (a replica image could be displayed)
- Garth Fraser models

Moderately sensitive objects requiring limited climate conditions of 15-25C, 40-60 RH, UV content below 80 u watt/lumen, illuminance below 200 lux. This includes:

- Wood (desiccated condition) – Track sleepers (to be excavated and displayed.) wooden cross bar and ceramic insulator, wooden survey peg, culvert timbers (timber frame used in Culvert /drain– this is large and dug out of the ground!) buffer timber
- Wood (sound condition) Stokers shovel, hammer and brush – wooden handles, tram timber components
- Wooden Cutlers desk
- Small wood objects with Painted/varnished surfaces
- Bristle - brush

- Painted surface – brush, hammer, advertising sign
- Rubber Hose attached to Tram

Least sensitive objects that can be stored in a wider climate range of 15-29C, 45-65% RH UV content below 200 u watt/lumen, illuminance below 1000 lux are:

- Tram (painted and varnished surface is sensitive, but does not constitute original fabric. The original Rubber hose is more susceptible and would be best stored elsewhere)
- Iron alloy (corroded) - tools, bolts, buffer, plus other large rusty metal on site at Wises farm, train track. These objects can withstand a wider climate range if they are stabilised and undergo conservation treatment.
- Metal – tram oil cans – these appear to have a plated surface and be made of iron alloy and tin alloy, with copper and brass components
- Glass - ink bottle, tram
- Ceramic – insulator

Original and significant fabric should be displayed in conditions that are within these proposed ranges to ensure preservation. It is not as critical to maintain environmentally stable conditions for replica fabric, however visual integrity would be maintained, and ongoing restoration costs would be significantly reduced if replica fabric is also kept in stable conditions. The following table outlines environmental conditions that are suitable for the storage of material types that constitute both original and replica fabric of the tram and related objects.

Summary of Materials Types and recommended RH and C conditions:

Organic Material - Temperature	12C - 25C (Horsehair) 15C - 25C (Acrylic, Fibreglass, Rubber, Polyamide, Ink, wood, plywood, paper)
Organic Material - Humidity	40 - 60 (, Horsehair, Acrylic plastics, Fibreglass, Rubber, Vulcanite, Polyamide, Wood 50 - 60 (Wax) 45 - 55 (Ink) 45 - 60 (Paper) 50 - 60 (Fragile Organics – such as desiccated wood)
Painted/Varnished surface -Temperature	15-25C
Painted/Varnished surfaces - Humidity	40-60 RH
Metals -Temperature	10C - 30C
Metals -Humidity	0 - 75 (Iron & alloys, Steel) (ideal below 45)
Ceramics and glass - Temperature	10-30C
Ceramics- Humidity	20 - 80 (ceramic) 40 - 60 (Glass, Bituminous materials)

(Cheung, McGeachie, Pedder, Quinn, Riboust, 2008, pp33-35)

The effects of environment on collection items has been closely researched by Conservators for many years now. Environmental recommendations have previously been based around Temperature 18-22C and RH 45% to 55%. The more flexible recommendations in the table above represent a shift in international conservation thinking towards relaxing the parameters that most institutions had previously been using. There is recognition that environmental parameters should reflect the climate where the museum is located, and that "many collections survived well in conditions that were not ideal."(Michalski, 2007, p.2)

For more robust large technology objects such as the Krauss tram, guidance can also be drawn from the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) Guidelines. The following table shows a summary of current museum climate guidelines, their purpose, collateral damage, and risks due to out-of-range events as assessed by ASHRAE:

Guideline	Tolerable range[a]	Tolerable short-term fluctuation[b]	Annual set point or average	Summer set point	Winter set point
ASHRAE class AA[e] (all references to "ASHRAE" are from ASHRAE, 2015)	45%–55% RH 14°C–28°C 57°F–82°F	±5% RH ±2°C	50% RH or historic average 15°C–25°C (loan rooms 21°C/50% RH)	Up 5°C	Down 5°C
ASHRAE class A, option 1[e]	35%–65% RH 9°C–28°C 48°F–82°F	±5% RH ±2°C		Up 5°C 10% RH	Down 10°C, 10% RH
ASHRAE class A, option 2[e]	40%–60% RH 9°C–28°C 48°F–82°F	±10% RH ±2°C		Up 5°C	Down 10°C
ASHRAE class B[e]		±10% RH ±5 °C	45% RH ~21°C 70°F	Up 5°C 10% RH	Down 10°C 10% RH
ASHRAE class C	25%–75% RH Not over 30°C (86°F)	±5% RH ±2°C			
ASHRAE class D	Below 75% RH	±5% RH ±2°C			

(Michalski, 2014, p.p.16-19)

From this table, the ASHRAE Class A Options 1 and 2 should be taken into consideration when formulating guidelines and set points for the Krauss. Class A is close to suitable conditions for Large Technology Objects. In particular it should be noted that the recommendation is that the RH set point is at 50% or the historic average. This refers to whether noticeable change to an object has been observed as a result of conditions already experienced in an objects current storage environment. The ASHRAE guidelines recommends that the historic average for a storage area can be used as a set point if collection objects had remained stable in conditions already experienced in an objects current storage environment.

As a starting point, it is necessary to analyse typical Buderim climate data to try and ascertain the average RH and the range of RH extremes for the different storage areas at TWRM. Checking against observable damage to objects will direct the choice of RH sets point. This approach acknowledges that it is safe for RH set points to acclimatize to an average that is more representative of the climate region that the museum is located in. (Michalski, 2014, p4)

Materials such as metals, glass and adhesives do need to stay within specific RH boundaries, but it is now known that a high frequency of fluctuation doesn't harm these classes of materials. (Michalski, 2014, p25) However, in the case of chemically unstable materials, 3 days per year outside of parameters (such as would occur in the event of an environmental crisis) is enough to cause mechanical damage (but not chemical damage). This is why unstable and fragile objects should be separated from other collection items and stored in more highly climate controlled conditions offsite.

Additionally, proofed fluctuation and evidence of fatigue fractures due to multiple fluctuations should influence the choice of allowable fluctuation. If fatigue fractures are not evident as a result of storage fluctuations experienced historically, it can be deduced that the collection item is able to withstand that degree of fluctuation, unless collection items have chemically deteriorated. This also needs to be quantified as to how many extreme fluctuation events have occurred in proportion to the years in storage; and how many extreme events can be endured in the future without causing damage.

Recommendations:

- If an HVAC system is not used, relocate objects of the most susceptible materials types to a more tightly climate controlled storage area off site.
- If light minimisation measures are not employed, relocate objects of the most susceptible materials types to a more tightly light controlled storage area off site.
- Installation of a climate controlled display case within the display building is an option if an air conditioning system is not used and budget allows. Different set points and parameters can then be employed for more susceptible materials types.
- House objects in terms of environmental/light requirements.
- Investigate options to de-accession /quarantine items in irretrievably unstable condition, items that have low significance, and items that are infested or pose a threat to other collection items in some way.
- Display copies of items that are at risk of damage in the display building. This includes the map, and label on the back of the painted metal sign.
- Where possible remove susceptible materials from non-susceptible objects (such as the paper label from the back of the painted sign), and replace with a duplicate.

6. Feedback on Concept Design – Buderim Design Studio (2015)

The building structure itself can serve as the primary means of regulating environmental conditions within a display space. If properly built and maintained, a well-sealed and insulated solid building constructed of masonry and other suitable materials can act as a buffer zone to minimise the effect and fluctuation of external climate conditions, plus provide good environmental conditions for the preservation of collection items. (http://culturalmaterials.net/wp/28-2/damage-and-decay/humidity-and-temperature/, p27-28)

The Krauss display building should provide an environment that can safely display and protect the Krauss Tram, ensuring that it can be preserved and maintained in appropriate conditions. It is possible that a collection of Tram associated objects will also be housed within this space. Display is also an important factor when devising such a building, however if preservation is also the objective, the design and choice of materials must take into account the preventive conservation measures required to mitigate the deterioration of the Krauss. It is important to ensure that the building has the capacity to moderate environmental conditions and slow the deterioration of materials.

The current design drawing proposes a building with an entirely glazed external surface to the display area. Unfortunately, outdoor display cases of this nature are extremely difficult and expensive to maintain and are likely to accelerate the deterioration of collection items stored inside. It is known that a 10C increase in temperature doubles the deterioration rate of many materials. Given the massive heat load and risk to the Krauss that will result from such a design, a reduction to the glazed area and modification of the design is highly recommended. The proposed building is still in the design stage, and from a preservation point of view, it would be preferable to create a fully enclosed structure away from the toilet block that is more typical of standard museum storage. Such a building would serve the purpose of maintaining the Tram in suitable environmental conditions, although would certainly not have the iconic display potential and massive audience of the current design.

The tram has excellent interpretive potential. It has been substantially but very sympathetically reconstructed. Significant thought needs to be given to this decision by all people involved in the project, and a decision made accordingly. Is the primary purpose of the Krauss as a display and interactive object that conveys part of the story of Buderim's history to a large audience, but for a more finite period of time? To be continuously restored throughout its lifetime? Or is it preferable to preserve the Krauss in its current state for a much longer time in a less visible way, as a museum object that forms part of Buderim's historical record?

If the decision is to continue with a highly glazed building design (in its current incarnation or a modified format), thought needs to be given to ongoing restoration costs, how frequently the tram should be restored, and to ensuring that the building design will allow continued onsite maintenance.

The current architectural plan for an opening at the ceiling will provide a well ventilated space, and has some benefits in that it does promote airflow and prevent a greenhouse effect from developing within the space. However, high ventilation will also significantly limit the buildings capacity to moderate climate from external Temperature and Relative Humidity extremes. It will also increase dusts, pollutants, water ingress, pest and vermin. This is of particular concern given the proximity of the nearby swimming pool and road.

The "glass box" design will promote significant heat load and high light levels. These high light, temperature, and RH levels will exacerbate deterioration issues. The climate in the proposed space will be uncontrolled and the building envelope will provide very minimal sealing or insulation. To some extent, the climate will be buffered by the thermal mass of the objects themselves.

Modifying building structure to reduce light ingress would significantly reduce the impact of light levels and ongoing maintenance of the Krauss. Some elements of the Krauss such as the rubber hose will degrade dramatically if kept in high light levels, and repainting will need to occur every 5 -10 years or so to preserve the Trams reproduction paint film. Light minimisastion is not so critical for the metal objects that comprise most of the Trams original components. The rubber hose and any original wood components will be adversely affected by high light, and it is recommended that these are stored elsewhere if a high light design is pursued. It should also be remembered that high light energy causes heating to occur, and deterioration caused by high temperature will also be accelerated.

Given the small size of the display space, and large thermal mass of the tram and other objects, consideration should be given to sealing the space and maintaining a controlled positive air pressure environment inside. This is best done with an air conditioner, but is expensive to maintain and not environmentally sustainable. Thought could be given to installing solar panels to offset this cost. This strategy would prolong the lifespan of the tram, and reduce housekeeping, maintenance, and restoration costs. It would also allow air filters to be installed, preventing the ingress of pollutants from the nearby swimming pool and traffic, prevent water ingress, limit pest and vermin access, plus minimize deterioration and corrosion associated with extremes of RH and C.

A less costly and less effective option would be the inclusion of a dehumidifier in the space to reduce RH levels. This approach would provide adequete storage conditions for the Krauss. Given the air volume within the space, a 2700cc dehumidifier would be sufficient. Running costs are likely to be 10c/hour when switched on. A fan (costing 1-3c/hour) should also be used to ensure air circulation. If this is not possible, the use of mobile dehumidifiers at times of disaster level RH should be regarded as a disaster mitigation strategy.

Using white or light coloured roofing and building surfaces, and spraying of the roof with simple sprinklers can reduce the surface temperature of roofing from over 45°C to typically 28°C. (Brown, Cole, Daniel, King, Pearson, 2002, p.56). This should be employed as a low cost option to reduce heat levels at times of extreme heat.

I would recommend at least some modification to the proposed design to prolong the lifespan of the Krauss. The construction of cement block walls on the West and preferably also the East ends of the display area are advised to increase thermal mass, protect from temperature and RH extremes, and minimise light levels. Ideally, these walls would abut the glazing. A room within a room layout with external cement walls built at a distance to the East and West ends of the glass display is also adequate. At the very least, timber look slatted screens should be constructed at the East and West ends to minimise light ingress.

There is also the possibility of creating small, more protective display microclimates within cavities of the sandstone wall, or creating a stand-alone display area near the main display area of an internal wall. If space and layout permits, smaller Krauss related historical objects could be displayed here.

Temperature, humidity and light is best reduced if the front of the building is also enclosed in a similar way, but clearly this conservation recommendation would involve some very significant compromises to the display potential of the tram, and also the safety of the toilet block area. When deciding on a final design, these factors need to be weighed up against the recommendations for conservation best practice.

Tree planting and a partial slatted screen extending down from the front face of the top of the roof would go some way to reducing light and heat ingress, as would a large awning attached to the front of the building. Excessive light levels and associated heat energy will be a significant cause of deterioration if the front of the building is not enclosed. However, given the non heritage nature of the surface finishes, this will not result in the damage of original materials. Chalking and failure of the paint coating will occur much more rapidly, but this coating could be viewed as sacrificial. Although expensive, there is the potential to repaint the Krauss in coming years. Other restored components such as the vinyl roofing and replica wooden components are susceptible to extremes of climate. Although they are not original fabric, they will quickly diminish in function and appearance.

As a means of control, highly sensitive materials such as paper should not be stored in this location, however some of these objects have component parts which are inherently under tension or made of sensitive materials such as paper, rubber, paint films, plastics, resins, waxes, and humidity sensitive metals. Original objects consisting of these materials should be stored at an alternative location or in a display microclimate, and a replica displayed in its place.

If long term off site storage is likely before the display building is complete, I would recommend the use of a custom made Carcoon to house the tram. As an example, a 10m x 5m x 2.5m costs approximately $2000-$2500 and was maintained with a2700/cc dehumidifier. A Carcoon could be expected to reduce RH by 17-19%RH. A Carcoon would prevent dust, and remove moisture from the storage environment, preventing mould and corrosion, and minimise the splitting of timbers and desiccation due to low and extremely fluctuating RH.

7. Buderim Climate Statistics and Recommendations

Buderim experiences a humid subtropical climate with hot and humid summers and mild to warm winters with cool overnight temperatures. Its historical climate statistics are not available, however climate statistics for the nearby town of Nambour are very similar, and a typical yearlong data set collected in 2006/7 is outlined in the table below:

	Monthly Relative Humidity and Temperature Statistics, 2006 - 2007											
NAMBOUR	Nov/06	Dec/06	Jan/07	Feb/07	Mar/07	Apr/07	May/07	Jun/07	Jul/07	Aug/07	Sep/07	Oct/07
Mean RH - 9 am	60	64	69	75	71	67	76	68	58	69	64	62
Mean RH - 3 pm	55	57	61	65	61	55	61	56	35	51	51	53
Maximum RH - 9 am	93	95	95	96	94	86	96	100	86	99	96	87
Maximum RH - 3 pm	97	80	83	96	80	70	94	99	66	97	96	95
Minimum RH - 9 am	26	50	56	58	58	49	52	35	25	30	24	22
Minimum RH - 3 pm	15	42	50	49	43	21	33	28	10	14	14	19
Mean Temp - 9 am	23.7	23.9	25.9	24.8	25.4	22.9	21.1	16.2	15.5	18.5	20.5	23.6
Mean Temp - 3 pm	25.5	24.9	27.6	26.0	27.2	25.1	23.8	19.1	20.1	21.6	23.8	26.1
Maximum Temp - 9 am	28.0	27.0	29.3	28.4	29.6	24.5	24.5	20.2	18.6	21.4	25.6	27.8
Maximum Temp - 3 pm	37.5	29.8	32.4	28.4	32.7	27.9	27.5	23.9	25.7	28.4	32.1	31.4
Minimum Temp - 9 am	19.2	18.6	19.7	20.2	22.1	19.7	18.5	10.7	12.3	14.7	14.3	19.3
Minimum Temp - 3 pm	19.5	19.2	22.9	21.2	24.4	22.3	18.3	12.4	16.9	14.7	15.0	21.0

http://www.bom.gov.au

The data in this table gives a close approximation to what the external environmental conditions at the proposed Buderim Krauss Tram display site will be. By comparison we are able to gauge the effectiveness with which the climate is likely to be controlled within the storage spaces for the Krauss. RH is usually high at night time in conjunction with low temperature. Low RH usually occurs during the day in conjunction with high temperature.

If the current Krauss display design is followed, I expect that RH will be moderated by approx. 10% from outside conditions, and closely mirror the external climate. There will be very little insulation against daily maximum external temperatures, although some moderation of daily minimum temperatures. Little protection from deterioration will be provided. This prediction is based on data that I have collected at a large technology object storage facility of similar construction.

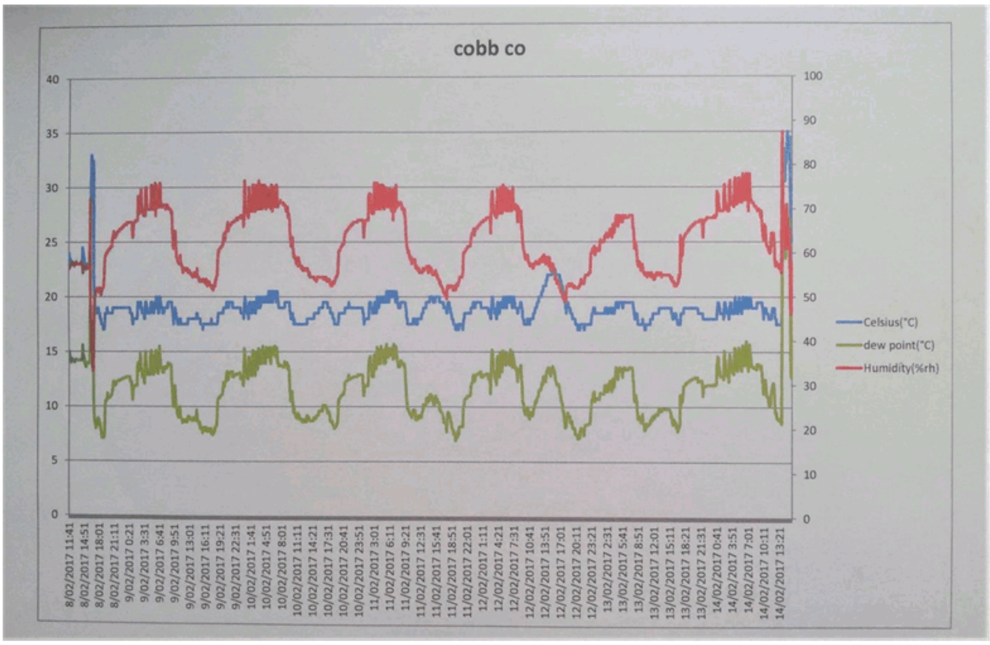
If a sealed masonry building of solid well insulated materials is built, a dehumidifier is installed, and external glazing is eliminated /significantly minimised, I expect that RH could be moderated by as much as 20% from external conditions, and 5-10C from external temperatures, bringing the environment much closer to within the recommended range for large objects storage and providing a suitable storage environment for long term preservation.

8. Comparison with Cobb and Co. Display Building at Rosewood

A display building of similar design is used at Rosewood near Ipswich to house a replica of the Cobb and Co Coach. This building was of all glass construction and was sealed, unventilated, and not climate controlled. The coach deteriorated and the splitting of timber components was observed. The coach quickly became mouldy in these conditions.

A large gabled 3m skillion roof structure with an insulated false ceiling space has recently been built around the glass display area to limit direct sunlight and associated heat load.

A 3500 kW unit standard external split system air-conditioning unit has been installed and a set point of 23C is used. Climate data was collected for a short period during the recent heat wave from 8 - 14 February 2017 as follows:



These external climate conditions should be viewed as a worst case scenario, and are at the limits of what this type of air-conditioning system is designed to cope with. At the time of data collection, the dehumidifier was not operational, and so this data represents control by the air conditioning unit only. Reports from Ipswich City Council are that the system usually maintains the space within a desirable climate range. This graph shows that in extreme conditions Temperature is maintained within a very close range of 17-22C and Humidity ranges between 50-79%, and usually exceeds the 70% baseline for mould growth overnight. Analysis of historic Ipswich climate data demonstrates that such high humidity is unlikely to occur at all other times of the year, but is possible during the summer and autumn months:

IPSWICH	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Mean maximum temperature (Degrees C) for years 1913 to 1994	32	31.1	29.9	27.5	24.1	21.5	21.1	22.8	25.9	28.5	30.8	31.9
Highest temperature (Degrees C) for years 1965 to 1994	43.4	40.6	38.3	37.3	32.5	28.6	27.8	33.4	36.4	40.3	43.9	44.6
Mean Temperature (mean Max + mean Minimum) / 2	26	25.4	24.1	21.1	17.5	14.8	14	15.2	18.3	21.35	23.85	25.35
Mean minimum temperature (Degrees C) for years 1913 to 1994	20	19.7	18.3	14.7	11	8.2	7	7.6	10.7	14.2	16.9	18.8
Lowest temperature (Degrees C) for years 1965 to 1994	14	13.9	10.1	7.8	1.3	-0.8	-0.4	0.2	4.4	6	9.4	8.2

http://www.bom.gov.au/climate/dwo/201601/html/IDCJDW4002.201601.shtml

Mean 9am RH %	67	70	71	72	76	77	74	68	62	60	60	63
Mean 3pm RH %	51	54	52	48	48	46	42	38	38	43	46	49
Mean Daytime RH	59	62	61.5	60	62	61.5	58	53	50	51.5	53	56
Mean 9am Dew Point	18.7	19.1	17.9	15.4	12.1	9.1	7.5	7.9	10.4	13.0	15.1	17.4
Mean 3 pm Dew Point	17.8	18.1	16.4	13.5	10.3	7.8	5.8	5.3	7.5	11.1	13.7	16.3

Monthly Climate Statistics Amberley AMO
http://www.bom.gov.au/climate/averages/tables/cw_040004_All.shtml

9. Conservation recommendations for appropriate building fabric and construction materials

The Conservation requirements are that the building is constructed in a manner that will preserve and protect the Krauss tram plus any related historic objects housed within the display structure. These recommendations relate primarily to the Conservation requirements of the Krauss Display Area component of the building and advice from a Structural Engineer, Builder, Architect and other related professionals should also be sought. To safeguard the tram, the building must have the capacity to moderate Temperature and Relative Humidity, Dusts and Pollutants, Light, Pests, Vibration, Mould, Water Ingress and Rising Damp/Efflorescence. Measures are required to ensure that

Security is maintained and that Disaster, and damage from People is mitigated. This can be done by adhering to the following Conservation recommendations:

9.1 Building Orientation:

To minimise heat and light the building should be located on an east–west axis. The western side of the building should be free of windows or else a screen should extend all along the western side, so that the proposed glass display area is fully screened from the western sun. The western side should have the smallest possible building surface area.

9.2 Site Selection and Preparation: To minimise the corrosion of metal surfaces, the Krauss display should be sited as far away from the nearby chlorinated swimming pool as possible. The swimming pool is a high humidity and high temperature environment, will pool temperatures kept at 27C and 32C. This produces an aggressively corrosive microclimate in combination with the Chloramines that off gas from the pool surface; plus the salts, acids and other chemicals that are also used in swimming pools. If possible, the building should not be sited downwind of the swimming pool.

9.3 Drainage:
A level site with good drainage, and situated away from overland flow paths, stormwater drains and waterways is required.

9.4 Building Surround:
Concrete paving, rock pits, gravel beds or ditches should surround the building to funnel water away from the base of the building.

9.5 Pest:
A pest inspection should be conducted on the site prior to construction. If there is evidence of any pests (particularly termites), they must be treated before construction starts. The building's exterior should be well sealed to prevent pest ingress. Garden beds should not abut the building structure. Guttering should be frequently cleaned and maintained to prevent the formation of pest habitats in debris and decaying plant matter. If regular gutter maintenance can't be ensured, sloped roofs with eaves that extend 600-900mm past the building should be used in preference to gutters.

9.6 Landscaping:
The surrounding landscape should be kept free of vegetation. Ideally, the area immediately surrounding the building should be paved or concreted. Any nearby rotted wood, flowering plants or tree stumps should be removed, as they attract insects and can cause pest infestation. Shady trees with non-invasive root systems should be planted in surrounding areas to increase shade and minimise light levels. (Ling, T, 2003, p7)

9.7 Size of Building:

The display space must be sufficient to house the Krauss tram, which has dimensions L 6.5786m, W 2m, H 3.2004m. A display design concept is yet to be devised, but if additional large train related items are also intended for inclusion in the display area, the size of the building footprint will need to increase so that it is adequate to house them.

Internal space must be sufficient to meet safety and design requirements for people to move around without injury to themselves or damage to the tram. If visitors and tour groups enter the display space, a 100cm distance between people, the tram and collection objects is recommended as a minimum to prevent damage from people. The sliding door design will provide extra space, so that the area can be made sufficiently large to safely house scaffolds, ladders and equipment that will be required for future in situ maintenance, repainting, repairs and cleaning of the tram.

9.8 Floor:

Some damp and efflorescence to a height of 15cm was observed at the base of the current toilet block site. To provide waterproofing, a heavy gauge polyethylene sheet should be placed beneath the concrete pad and strip footings and turned around the side of the base before concrete it is poured. The concrete mix should be submitted for approval to a structural engineer, to ensure that a mix low in fly ash is used, and generation of alkaline dusts is minimised.

The Concrete floor requires internal steel reinforcing sufficient to bear the approx. 20 tonne weight of the Krauss. Steel Reinforcing should be coated with an anti-galvanic moisture barrier. This is essential in control joint dowels and where there is a possibility of exposure. The concrete should be cured for 4 weeks, and all cracks and holes must be filled before coating. The surface must be dry and free from all efflorescence, dirt, dusts, loose scale, powder, oil and grease. The surface of the new concrete should be etched with muriatic acid to ensure film adhesion, then thoroughly washed to remove all acid, and allowed to dry completely (moisture content less than 15%). Following this, the floor should be coated on the sides and the top of the concrete pad to prevent water ingress.

Ideally, the floor should be coated with an epoxy formed by catalysed polymerisation to minimise alkaline cement dusts. It will also ensure an inert, easy to clean, and chemically resistant coating if treatment of the Krauss is necessary at a future point in time. Other suitable coating options are urethane formed by moisture cure or catalysed polymerisation, although chemical resistance is not as great. (Tetrault, J, 1999, p10-11)

9.9 Roof:

Corrosion resistant steel roofing sheets such as Colourbond should be used. To prevent corrosion from dissimilar metals, any accessories, fastening clips, apron flashings, gutters or downpipes should have the same galvanic activity as the colourbond roof.

A white or light coloured roofing material should be used to reduce heating. The pitch of the roof should be 12° or greater to prevent rainwater from pooling and entering the building.

To increase shading and ensure roof drainage falls away from the base of the building, the eaves should overhang the walls by a minimum of 600-900mm. At the front of the building, this overhang should be 1.8m to reduce light ingress into the display and provide sufficient shading. A false ceiling should be installed, and the roof cavity should be sealed and sarked. Ideally, consideration should be given to including both ceiling insulation and roofing insulations to practicable limits. The more insulation the better. Polyester batts are preferable so that fibreglass dusts are not generated. At the very least, insulation with an R3 rating or greater is required to help moderate the environment within the building.

9.10 External Walls:

It is preferable that the walls are of cement block construction, to ensure good insulation. Bricks are also suitable. Timber is susceptible to termite attack and should not be used. If stud framing is used, metal studs should be utilised. The exterior walls should be painted with a good quality light coloured paint containing a mould inhibitor. Walls should be resistant to moisture and it is preferable that walls are rendered. Paint coatings improve water resistance, and light colours are reflective and reduce the heating within the building. Some thought will also need to be given to how to best protect the footings/lower wall of the display area from floor cleaning chemicals and water ingress from hosing down and mopping the nearby toilet area.

9.11 Internal walls and ceilings:

The building interior should be sealed to limit the ingress of dusts, pollutants, water, pests, vermin, and help maintain a stable weatherproof environment within the display. Walls and Ceilings and walls should be constructed of fibre cement. Building gaps should be eliminated with neutral cure silicone sealant at all junctions (eg. Dow Corning 747), as is standard for the construction of food preparation areas. Good quality light coloured paint should be used, and walls should be insulated to maximum practicable limits. The more insulation the better. Polyester batts are preferable so that fibreglass dusts are not generated. At the very least, insulation with an R3 rating or greater is required to help moderate the environment within the building.

9.12 Paint:

Water based Acrylic paint (low VOC) such as Wattyl Clean Air or Dulux Breath Easy should be used. Paints that form films by oxidative polymerisation and solvent evaporation will off gas organic compounds and should be avoided.

9.13 Doors:

Outward opening or sliding doors should be used as entry points to the display. Doors should be large and extend much of the length of the display area, so that the tram can be accessed for maintenance. Doors should be well sealed to minimise the ingress of dusts, pollutants, water and pests, plus help maintain a stable environment. Neoprene synthetic rubber or silicone should be used on door seals. Building entrances should be sheltered or located away from the direction of prevailing winds if possible. It may be useful to install a door on the eastern end of the display, So that the tram can be installed after construction is completed, and in case the tram ever needs to be removed from the display building at some future time.

9.14 Windows and Glazing:

Direct sunlight should not reach the tram and glazing to external building surfaces should be minimised. From a Conservation point of view, ideally, the tram display should be walled on at least the east and west sides, or alternately the east and west display glazing could be surrounded by a wall or screen to form a room within a room configuration. This would significantly reduce heat load and high light levels. Ideally, the front of the display glazing should also be surrounded by a screen or wall to protect it from direct sunlight. A large photograph and signage on this wall could be used to advertise the presence of the tram within the space. Alternately shade screens or awnings attached to the front of the building would reduce heat and light ingress.

The size and thickness of glazing panels should follow the recommendations of a structural engineer. The interior of glazed surfaces should be covered with the tinted 3M Prestige window film product PR40 to reduce lux and UV light levels.

If Sealants are used around glazing, a neutral curing silicone sealant that doesn't emit acetic acid should be used. Only use spacer gaskets, glazing tapes and setting blocks that do not deteriorate in UV light and are compatible with the sealant. Polyethylene tapes, rods, and foams should be used with sealants, in preference to other less stable types of plastic and foam based materials.

9.15 Security

High quality locks or a security alarm should be connected at all doors. Only authorised people should have access to the display site. A security camera should be installed on the premises.

The exterior of glazed surfaces should be covered with an anti-graffiti film coating. It is suggested that small size glazing panels be used, so that they are less expensive to replace if vandalism or breakage occurs. A railing at arms distance around the glazing is recommended to keep handprints off glazed surfaces and reduce cleaning costs.

9.16 Lighting:

Ideal light levels for the tram is below 200 lux and below ….UV ... If artificial display lighting is required, dimmable, adjustable LED lights such as the mini-LED power downlights from Light Projects IBL range are suitable. (http://lightproject.com.au, 2014) Alternatively, fluorescent lights with low UV, and illuminance of 200lux are suitable and should be covered with a diffuser. Light damage is cumulative and movement sensor switches should be fitted to turn off lights when they are not required. LED Spotlights are preferable to conventional spotlights that, can create local pockets of high temperature and low RH.

9.17 Electrical:

Power outlets will be required if a dehumidifier, air conditioner, fans or lights are used. To reduce costs, solar panels could be used as a power source.

9.18 Environmental Control (air-conditioning, ventilation)

For collection types similar to the Krauss Tram, ASHRAE recommends the relaxed environmental parameters of 45-65%RH and 15-29C.

Environmental conditions should be kept within these parameters to ensure that the tram is preserved and to prevent mould growth. This is best achieved by the use of an air-conditioning system. This also has the benefit of creating a positive air pressure environment within the space to prevent ingress of dusts and pollutants.

However, if the building is built in a way that reduces heat load and minimises the amount of direct sunlight entering the display area (as outlined in these conservation recommendations), a lower cost alternative is to use a dehumidifier in conjunction with a fan. The dehumidifier should be plumbed into the drainage system.

If an air conditioner or dehumidifier is used, power use could be minimised by use of a humidistat. This would be programmed so that the unit switches off during ambient external climate conditions, which is approximately equivalent to 4-6 months of the year. This is suitable as long as fans were still used to circulate the air and prevent the settling of mould spores. At other times of the year, running costs could be reduce if the air conditioner or dehumidifier was run on a time cycle with regular switch off periods and passive acclimatization.

Based on electricity costs of 26c per kWh:

- The average cost to run a 2400 dehumidifier is 10c/hour.
- The average cost of a small 1000w air conditioner is 26c/hour.
- The average cost of a medium 2300w air conditioner is 60c/hour.
- The average cost of a large 3200w air conditioner is 84c/hour.
- The average cost of a very large 5000w ducted air conditioner is $1.31/hour
- The average cost of a 40w exhaust fan is 1c/kWh.
- The average cost of a 100w ceiling fan is 3c/kWh.

9.19 Atmospheric Pollutants:

The display building should be well sealed to minimise the infiltration of outside air and buffer against the ingress of external air pollutants. If an air conditioner is used, atmospheric pollutants should be removed from the display environment by using a filtration system and regular air changes. “Ideally, a filtering system for the air is maintained such that 50% of particulates are removed (ASHRAE dust spot efficiency test) and that airflow is such that there are no bad air zones that allow mould and mildew to develop” (Thomson, 1978, p36). To achieve this, “the air filtration system should incorporate activated charcoal filters in addition to the viscous (oil based) impingement filters to remove any acidic or oxidising gasses from the atmosphere.” (Pearson, 1997, p10). Filters used should be changed annually and have the capacity to reduce pollutant levels to within the following limits:

- Pollutants - less than 5% of outdoors
- Ozone – trace levels
- SO2 NO2 - less than 10ug/m3

9.20 Disposal of Waste and Refuse

Solid liquid and gaseous contaminants should all be removed from the construction site before being disposed of appropriately at an approved location away from the construction site. The Building site should be kept clean during works and handed over in a clean state at practical completion. When metalworking is occurring, any metal filings, dusts and offcuts, plus screws bolts and fastenings should be thoroughly cleaned from surfaces and removed from the site to prevent galvanic corrosion with the tram.

9.21 Care and use of Products and Materials

Products and materials should be undamaged and stored, and handled in accordance with the manufacturers' recommendations and methods. If any products or materials are found to be defective, they should be rejected. Work should be conducted at times of Temperature RH that is optimum for that product or material. This will prevent any damage and deterioration that could generate pollutants or compromise the display environment. If any dissimilar metals are in contact with each other, they should be isolated with an inert barrier material to prevent galvanic activity and corrosion. Any coating and protections to any steel members needs to include any base plates underneath. Particular care needs to be taken with any inspection and test planning, and all coverable works should be highly inspected.

9.22 Installation of Tram and collection objects in the Display Building

From a Conservation point of view, it does not seem feasible to construct the display building around the tram without great risk to the tram and the safety of construction workers. An engineer should be consulted to advise on how to install the tram once the building has been completed. An engineer can advise on any architectural modifications that may be required to doorways to ensure that the tram can be installed. If the tram must be installed prior to completion of the building, a Conservator should be engaged to advise on the construction of a protective barrier and covering for the tram, and to train building site staff on how to work without damaging the Tram.

10. Required off-gassing times for products and materials prior to the Installation of Tram and Objects

The following off gassing times for products and materials should be adhered to before the Krauss tram or associated collection objects are installed:

8-6 weeks - plaster work

6 weeks - solvent based paints

4-2 weeks - use of adhesives (including spray mounting)

2 weeks - glazing and painting completed

2-3 weeks - sealants

2-3 weeks - water based paints
(Hornimann)

11. Support and display materials

Display areas will likely take the form of a main display area, with the possibility of smaller display enclosures in the surrounding building, such as recessed into nearby walls of the same structure. If objects other than the tram are intended for display, it would be advisable to create some small display areas within the building structure. This prevents crowding of the display area and gives the opportunity to create display microclimates for more susceptible classes of materials.

Support and Display materials should be inert and chemically stable. Any alternative materials should be assessed by a Conservator.

Suitable Materials for internal display case surfaces and mounts:

- Powder coated metal
- UV filtered glass - eg. DMS Envirolam
- Water based Acrylic paint (low VOC) – eg. Wattyl Clean Air or Dulux Breath Easy (leaving 2 weeks to off gas prior to installation)
- Plastics and foams – polyethylene eg. Ethafoam, Polypropylene eg coreflute, polyester eg Mylar.
- Adhesives - Acrylic Adhesives
- Fabrics – cotton, linen and parsilk (must be washed using lux flakes before use, and have fixed dyes)
- Wood – Hoop pine plywood (exterior grade), marine ply, ZF MDF. Wood must be sealed on all surfaces, especially the end grain using either a 2 part epoxy lacquer (preferable to water based acrylic) or a clear water based acrylic lacquer such as Wattyl Speed Clear or Cabot's Crystal Clear.
- Silicone sealant – neutral curing such as Dow Corning 747 that doesn't emit acetic acid
- Seals – neoprene synthetic rubber or silicon
- Acrylic Sheeting – Perspex or Plexiglass
- Polyester Padding – Dacron

- Paper, tissue, cardboard, mount board – Archival Quality, acid free, 100% rag
- Silicone dots – 3M bump-on
- Tyvek
- Hotmelt adhesive – 3M Jetmelt for attaching supports together
- Foil/plastic laminate – Marvelseal and Moistop for sealing internal surfaces and preventing off gassing
- Mount materials to be manufactured from Perspex, stainless steel or brass covered with silicone tubing or polyethylene, and to provide appropriate padding and support to any fragile or soft areas.

12. Object handling and installation

Detailed advice on handling installation is required but is beyond the scope of this report. A Conservator should be consulted to advise on the safe installation of objects. The tram can be rolled a small distance of a few metres. The instructions provided in Appendix 1 of the Buderim Palmwoods Tramway Book should be followed during installation.

The Logistics of installing the Tram and how it fits into the building and construction sequence of events needs to be considered, and advice sought from a Construction Project Manager and Engineer.

13. Conservation guidelines for exhibition

- Active corrosion is present beneath the paint film and at joins and edges of metal components. It is recommend that corrosion is stabilised and treated with corrosion inhibitor prior to installation and display.
- The tram requires cleaning of dust dirt and debris that has accumulated on the tram as a result of outdoor storage.
- Thorough cleaning and stabilisation of surface corrosion is recommended prior to display. A rust inhibiting solution should be applied.
- Enclosed areas of the tram such as the boiler should be closed inspected for corrosion and a treatment /maintenance plan devised.
- A protective coating should be applied to the tram after repainting.
- Some minor repairs will be required prior to display (e.g. - wooden peg broken off steering mechanism, and splitting to facsimile timber components at wheels as a result of Relative Humidity fluctuation).
- Steel track is to be excavated from Wises Farm and displayed with the tram. Thorough cleaning should be undertaken to remove soil, pests and debris before display.
- Inconspicuous screens should be applied to any rodent or insect pest ingress points.
- Ensure internal tram spaces are free of mud wasps, pest and vermin.
- Replacement seasoned timber sleepers treated with a timber preservative should be used. If the original timbers are used, there is a high risk of insect pests and borers entering the new display space. The ongoing loadbearing capacity of the existing sleepers is also uncertain.

- Deteriorated, fragile and corroded items that form part of the Tram collections should undergo Conservation treatment prior to display
- Ensure a space of 1m between people and collection objects to minimise the amount of heavier dust affecting the object.
- Accession numbers and durable identification tags should be attached to collection objects.
- Condition photographs should be taken immediately following installation.
- The display should be regularly maintained in accordance with a Preservation Housekeeping Schedule, Condition inspection schedule and display maintenance regime
- Ensure that the the display space is sufficiently large to house scaffolds and ladders for maintenance and cleaning of the tram.
- Given the limited space, some curatorial decisions may need to be made in limiting the amount of objects on display. The authenticity, interpretive potential, condition, and fragility of objects should guide this decision making process.
- Traffic within the display and on the train should be kept to a minimum, to reduce damage and the ingress of pests, dusts and pollutants.
- Inspection and extermination of pests is required prior to installation.
- Any organic “prop” materials or objects showing signs of insect infestation should be frozen prior to display
- Leaves and soil are not to be included as part of the display.
- Original paper or textile based materials are not suitable for display at this light level, and replicas should be displayed instead.
- Track support needs to be level and sit squarely on the floor. The tram must be raised above ground level to allow air circulation.
- Ensure that the load rating of blocking is adequate.
- New sleepers cut from seasoned timber are required to support the track. These should be treated with a timber preservative such as Zinc Napthanate.

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