

10. Spray bottle containing distilled water
11. De-ionized tap water, continuous supply with plastic hose
12. Distilled water, 40 liter in plastic cans, with plastic pouring jug
13. Clean compressed air with suitable handheld nozzle.
14. SALT Primary Mirror Segment Washing Trolley (Segment Holder removed)
15. Blue high-powered LED flashlight
16. Red flashlight
17. SAC mirror coating witness samples
18. M5 removal jig
19. 2 sets of scaffolding
20. Rubber Support Pads

4. Materials Qualification

1. The water will be qualified using a handheld conductivity meter.
2. The cotton wool will be from an as yet un-opened bag and meet the requirements specified earlier in the document.
3. All compressed air filter cartridges must be replaced and subsequent air quality be verified and continually monitored. The air flow through the handheld nozzle must be choked to a safe level. The air must meet the dew point measurement. An additional test will be to blast a clean sheet of paper and then study it for contaminants (oils, fine debris etc).

5. Precautions

It is important to take precautionary methods, before commencing the cleaning process of the mirror, to reduce the risk of injury and damage:

1. Operators wearing glasses must fit a retainer string preventing their glasses from falling off.
2. Operators must cover belt buckles, and remove watches, cell phones, money and all other items from pockets.
3. Operators must always wear clean surgical gloves.
4. Do not re-use cotton wool which has dropped on the ground.
5. Avoid contact with the eyes when washing with sodium lauryl sulfate (SLS)
6. Aprons should be worn.
7. It is important for the operator to hold the air gun securely and not to knock or touch the mirror in any way.

6. Personnel

The following persons must be present during the cleaning process, their tasks as indicated:

1. Darragh O'Donoghue – process manager, has final authority
2. James O'Connor – De/re-installation and transportation of M5
3. Francois Strumpfer – De/re-installation and transportation of M5
4. Lisa Crause – Photography
5. Hitesh Gajjar – Process expert
6. Jonathan Love – The only person executing the washing procedure due to his extensive experience in cleaning the SALT primary mirror segments.

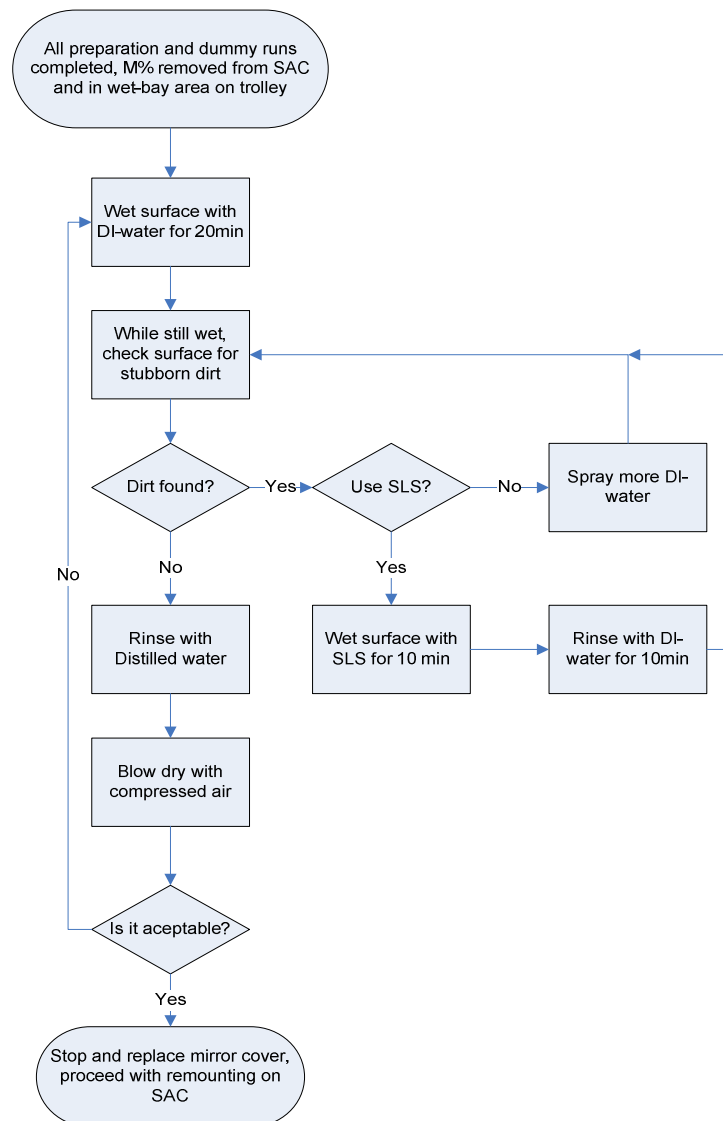


Figure 1: Cleaning process overview

7. Cleaning Process Overview

This is shown schematically in Fig. 1

8. Process Verification and Trial Run

In order to verify all the equipment as well as the individual process steps, two steps are required:

- ❖ The cleaning procedure listed below must first be performed on the SAC coating witness samples.
- ❖ A glass or aluminium dummy or mockup of the M5 mirror should be transported from the SAC to the washing bay and the procedure executed on it. Any lessons learnt during this run must be reworked back and documented into the final procedure. Each process modification must be performed and repeated until final satisfaction and consensus have been reached.

9. M5 Removal Procedure

1. SAC Preparation

1. Remove Top Structure and related equipment []
2. Remove M4 and stow in proprietary container []
3. Remove M4 Carrier Annulus []
4. Use the Faro Arm to measure the backplanes and ODs of M2 and M5, as well as invar buttons on these mirrors as well []
5. Remove M2 Retro Reflector []

2. M5 Preparation

1. Put on Mirror Cover(s) []
2. Slide in 2 x Bottom Carriers []
3. Attach 4 x Side Brackets []
4. Attach 2 x Top Carrier Straps []
5. Slide in 4 x Foam Spacers []
6. Attach 4 x M10 threaded rods []
7. Fit Lifting Frame []
8. Lift M5 approx 10mm with nuts on threaded rods []
9. Mark orientation of frame on top ridge of SAC (masking tape). []

10. Undo the shoulder bolts on M5 and secure tangential arms to the side of the cage (duct tape).

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3. M5 Lifting Preparations

Erect 2 scaffolds on the open sides of the Simulator (3 rung vertical sections on aisle side with platform on middle rung - ensure secure cross bracing).

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4. Lifting M5

1. 2 People to lift M5 to a height of approx 50mm clear of SAC Cage with a further 2 to ensure unobstructed lifting.

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2. Transport the assembly manually to the edge of the scaffolding. []

3. 4 People receive the assembly and move it to the Washing Trolley.

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4. Place the assembly on the Support Pads. []

5. Remove the Lifting Frame. []

6. Remove the Carrier Frame. []

10. Cleaning SAC

With M5 removed and the back surface of M2 exposed, remove all loose dirt by vacuum, using the cleanroom vacuum system. All exposed non-sensitive surfaces must now be cleaned by wiping them with a lint-free damp cloth, followed by some more vacuum suction.

11. Cleaning Procedure Steps

- ❖ Jonathan Love will be the only operator performing the washing and drying tasks.
- ❖ It is assumed that at the outset of this procedure, M5 is supported on the SALT Primary Mirror Segment Washing Trolley, its weight being supported from its back side and water must be able to freely flow through its central hole.
- ❖ The mirror surface must be kept wet at all times; do not allow drying of surface. If drying does occur, wet with distilled water.
- ❖ The number of complete washing-and-drying cycles must be kept to a minimum due the possible risk of streak marks forming during the drying step and the removal difficulties thereof.

The Process:

1. Mirror inspection and assessment: Mirror to be inspected in both red and blue light with close-up images taken for documentation purposes – Lisa et. al.
[]
2. Mix fresh sodium lauryl sulphate: concentration TBD – Jonathan
[]
3. Remove mirror cover
[]
4. Wet M5 for at least 20 minutes with deionized (DI) tap water to remove any dust particles from the surface. Check for surface tension breaks or unevenness which will indicate oily contamination. The presence of surface tension breaks will most likely necessitate the use of soap (sodium lauryl sulfate), see next Step. Also rinse the sides and rear of M5 and the trolley. []
5. While still wet, check for stubborn dirt. If dirt found, rinse mirror further for another 10 minutes. If no improvement, DOD to decide whether to use sodium lauryl sulphate. If the decision is Yes, proceed with Steps 5 to 8; otherwise soak further or proceed to Step 9.
[]
6. Saturate the cotton wool with diluted sodium lauryl sulphate and soak onto the surface of the mirror where the stubborn dirt is located. Runoff should be continuously rinsed down into the central hole. Allow the SLS to react for 5-10 minutes while rinsing the runoff into the central hole. Do not rub the mirror as particles may be suspended in the sodium lauryl sulphate and can lead to scratching of the surface.
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7. Rinse for 5 minutes with DI-water and check if surface is acceptable, if OK skip Step 8.
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8. Apply sodium lauryl sulphate again as in step 5. Allow to react for 10 minutes. Then lightly brush over the regions of stubborn dirt with a soaked cotton wool swab. Do not rub the mirror surface with cotton wool but rather brush lightly over the problem areas using the weight of the cotton wool only.
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9. Rinse thoroughly for 10-15 minutes all surfaces, sides and rear sections with deionized tap water, working from underneath first then over to the mirror surface.
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10. Rinse thoroughly with distilled water, starting by spraying the bottom and sides first and working up the optical surface. The optical surface should be rinsed repeatedly using pouring mugs full of distilled water. []

11. The drying of the mirror will be performed by blowing the optical surface and cloth drying the rear. It has been found to be exceedingly difficult to blow dry more than one face without getting water droplets from sputtering and contaminating the remaining faces. Proceed by quickly drying the edge of the mirror using lint free wipes, then continue with the air drying of the optical surface, and then tackle the rear surface also with lint-free wipes.

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12. After mirror is completely free of water droplets, examine entire surface for any dirt or watermarks. It is recommended to dim the lights and use a torch to examine the mirror surface. A blue high-powered LED works extremely well when shone across the mirror surface. If mirror is unacceptable, start again from Step 3.

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13. Mirror inspection and assessment: Mirror to be inspected in both red and blue light with close-up images taken for documentation purposes – Lisa et. al.

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When satisfied that the mirror is clean and dry the mirror must be covered and can now be transported to and remounted in the SAC.

12. Remounting M5 on the SAC

1. Lowering M5

1. Replace the Carrier Frame. []
2. Remount the Lifting Frame. []
3. Check/adjust the height of the carry frame so that, when lowered back into the SAC, it will not make contact with M2 but rest on the SAC Cage. []
4. 4 Persons carry the assembly from the Washing Trolley to the edge of the scaffolding.
5. 2 Persons to lift M5 to a height of approx 50mm clear of SAC Cage with a further 2 to ensure unobstructed lifting, then lower M5 so that the lifting frame is supported/resting on the SAC Cage. []
6. Check/realign orientation mark of frame on top ridge of SAC (masking tape)

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2. M5 Finalizing

1. Loosen tangential arms from the side of the cage (duct tape) and replace on shoulder bolts []
2. Fasten the shoulder bolts on M5 []
3. Lower M5 approx 10mm with nuts on threaded rods []
4. Remove Lifting Frame []
5. Remove 4 x M10 threaded rods []
6. Slide out 4 x Foam Spacers []
7. Remove 2 x Top Carrier Straps []
8. Remove 4 x Side Brackets []
9. Slide out 2 x Bottom Carriers []
10. Remove Mirror Cover(s) []

3. SAC Finalizing

1. Replace M2 Retro Reflector []
2. Use the Faro Arm to measure the backplanes and ODs of M2 and M5, as well as invar buttons on these mirrors as well. Check the measurements against those made prior to M5 removal []
3. Replace M4 Carrier Annulus []
4. Replace M4 []
5. Replace Top Structure and related equipment []

4. Finalizing

Dismantle and remove the scaffolds []

Comments:
