

MicroBooNE internal note: Cleaning procedures for the TPC parts

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This document describes the procedures used to clean the different parts of the MicroBooNE TPC, as a more extensive version of doc-db 2141-v4. We will evaluate at which point changes were doen with respect to the planned procedure, and to which extent these change the results which were planned to achieve. In the end we will point out suggestions for improving future designs studies.

Contents

1	Introduction	1
2	Predefined Cleaning Procedures	1
3	Cleaning Procedure evolution	2
4	Actual Cleaning Procedure	4
5	Suggestions for future large LAr TPC's	12

Introduction

The MicroBooNE TPC was built and assembled by a group of Summer -, Graduate students and Post-Docs in Summer 2012 till Fall 2012 under the supervision of John Voirin and Jen Raaf. As first major step in the assembly, a dedicated cleaning for all TPC parts was needed to make sure that the high purity, required to observe drift in liquid Argon, can be achieved. Part of the procedures for cleaning were defined before the final design of all parts was finished, thus a few adjustments were needed to the previously planned operations. We will review the procedures, already submitted at MicroBooNE doc-db 2141.

Predefined Cleaning Procedures

In the MicroBooNE doc-db listed are several documents that handle the idea for cleaning the parts of the TPC. During the DOE3 review, the QA/QC documents were set up, and can be found at doc-db 1820. Here it is stated that:

- Cleanliness Requirements: Before assembly, the detector parts must be cleaned such that once assembled and filled, the required Liquid Argon purity can be achieved and maintained. The vessel, TPC parts, and PMT rack parts will be cleaned with Simple Green and deionized water before final assembly

During the evolution of the final detector design, a more detailed procedure was developed and can be found at doc-db 1922 and 1923, where it is stated that:

- Stainless steel parts
 - Wash with brushes/lint free rags, Simple Green + distilled water
 - Rinse in bath of distilled water (field cage tubes by pushing water through via hose)
 - Dry with rag, then warm-air (heated air pushed through fan)
 - Wrap in plastic
- G10 parts
 - Wipe down with lint-free rags and distilled water
 - Rinse in distilled water
 - Bake at least 24 hours at 100-150 under vacuum (actual temperature to be determined later)
 - Wrap in plastic

The pre defined procedure was based on the delivery assumption of stainless steel items which were deburred. The G10 parts were expected to be cut with a water jet.

Cleaning Procedure evolution

When the actual delivery of items to Fermilab started and the assembly group made of Summer, Graduate students and Post-Docs came to Fermilab, the cleaning procedure plans were adapted to the need of the actually situation and limited possibilities. We can identify to big cleaning periods, the period one which contained most of the Anode and Cathode frame parts, and the period two where the field cage tubes and couplings arrived.

The required rinsing with distilled water proved to be impossible for the TPC parts. This was due to the fact that a high pressure water jet was required to rinse the steel parts forcefully enough to wash off/out the detergent and the remaining steel chips (see Figure 1) due to fabrication, which was not installed at Lab F for either de-ionized or distilled water. We got access to tanks with de-ionized water, which was used to prepare small baths in which smaller pieces could be cleaned. For larger pieces (>2 feet), a C-channel cleaning setup was used, which was running with regular tap water (see Figure 2). All in all, the small basins had to be changed with water regularly, as the delivered items were rather dirty/greasy or contained a lot of shavings due to the machining (metall) or fine fiber flakes (G10). Additionally, a lot of permanent marker writings, dirt smears, rust



Figure 1: Small machining pieces inside welded suport beams.



Figure 2: C channel used for rinsing and cleaning larger metall parts.



Figure 3: Preparation of the DAB TPC assembly tent Sanding of the supports.



Figure 4: Preparation of the DAB TPC assembly tent Sweeping the floor.

spots and dried oil from machining was not possible to be cleaned by brushes and rags only, thus a scrubbing and cleaning with brown ScotchBrite 7447 needed to be done for nearly all metals. This step left a very fine grey layer of dust on the pieces, which could be removed by running a Kimwipe over the tubes, and we ensured to take all of this off by implying an additional alcohol wipe at the end of the procedure. We observed that the drying for the long pieces took up to a few days sometimes, which was time enough for regular dust to settle again on the items, thus an additional alcohol wipes was done for several of the items before wrapping them in plastic.

The next item which needs to be mentioned is the preparation of the assembly tent at DAB site. To make sure that we do not spoil the cleanness of the pieces, the Aluminium supports were sanded (see Figure 3) and the floor was swept clean (see Figure 4), before the shipping of the cleaned parts.

In MicroBooNE doc-db 2141 a revision of the cleaning procedures is outlined, where it stated that:

- Parts will be de-burred to remove any sharp areas.
- Using brushes and lint free rags SS components will be washed down with simple green and distilled water to remove any particulate. If possible smaller parts will be put into the available ultrasonic cleaners and cleaned.
- Parts will then be rinsed with distilled water and allowed to dry in a clean environment.
- The current process for ultrasonic cleaning of smaller parts is:
 - Pre-rinse in tap water, wipe of big dirt flakes with hand
 - 1st sonic bath wash, heated distilled water with Citranox , simple-green or some acceptable detergent. (15 minutes = max allowed time on bath timer)
 - Rinse with distilled water in a bucket, wipe with kimwipes
 - 2nd sonic bath wash, heated distilled water w/cleaner detergent(15 minutes) (new solution needed)
 - Final rinse, 2x with distilled water (no sonic, just 2 buckets)
- After cleaning parts will be wrapped in plastic or stored in bags. Pipe ends will be sealed.
- G-10 parts will be cleaned in an ultrasonic cleaner with the elma clean 65 from Tovatech LLC. The parts will then be baked in a vacuum oven and sealed in plastic.

Over the course of time, this note was updated and changed to the actual procedure, thus we have parts, which were cleaned by a different way, and will go into detail in the next chapter. Nevertheless, this note gives a good overview on the actual requirements of the cleaning, and should be consulted for future experiments.

Actual Cleaning Procedure

As already mentioned, the usage of distilled or de-ionized water proved to be futile for the larger parts of the TPC frame, due to the fact that they were very dirty and had a lot of metal shavings or fine fiber flakes that could not be removed with a simple rinse, but required a strong water jet. As these parts were mostly hollow pipes (or beams), we also run into trouble on how to clean the inside of these parts. At first, we used a dedicated brush with an extension to run them through and thus clean them from the inside, which worked very well for the larger diameter beams (see Figure 5). For smaller diameter beams and tubes, this method was not working anymore.



Figure 5: Cleaning of beams with a special brush.



Figure 6: Soaking of beams in a simple green solution.



Figure 7: Sanding of the beams for very dirty parts.

For a large fraction, we tried to solve this by soaking the pipes in a simple green solution (see Figure 6), and running them through with sponges and later on Kimwipes, until the Kimwipes were showing no remaining stains. The number of run throughs was varying largely, sometimes three times of using the Kimwipes would be fine, other times a beam from the same pile would require ten trials. All in all, the soaking seemed to work very well. As already mentioned the outside needed to be cleaned with Scotchbrite, partly we had to use a sander to get rid of the dirt which remained on the parts (see Figure 7).

The next trouble we ran into was the cleaning of the Cathode sheets. Due to their large size and sharp edges, their were a difficult piece to clean. We build a special bath were they could be fitted and soaked in a simple green solution (see Figure 8) and rinsed them with a water jet (see Figure 9).



Figure 8: Cathode sheet scrubbing.



Figure 9: Cathode sheet spraying.



Figure 10: Cathode sheet alcohol wipe.



Figure 11: Cathode sheet wrapping.



Figure 12: Cathode sheet shipping.



Figure 13: Cathode sheet shipping.

Afterwards the sheets got cleaned with an extensive alcohol wipe (seeFigure 10) and wrapped in plastic (seeFigure 11). Later, the sheets were shipped to DAB (seeFigure 12 and 13). For the handling of these sheets, we have to mention that the handling was rather unpleasant, as the sharp edges tended to destroy gloves and also their size and

weight was on the upper end of human handling capability.

As the final cleaning procedure was developed on the spot, some parts which are small were not cleaned with an ultrasonic bath, these are mostly parts D00-M-345, 346, 349 and 353. Also the small G10 parts were not cleaned with this ultrasonic procedure. They are handled with the following procedure:

- Metals: Cleaning with Scotchbrite in Simple Green solution
- G10: Cleaning with brushes in distilled water
- Rinse in distilled water,
- Dry in clean tent area
- Alcohol wipe
- Wrapping in plastic

All other large metal TPC metal parts were cleaned as follows:

- Cleaning with Scotchbrite and Simple Green solution
- Rinse with water,
- Tubes only: Cleaning of the inner pipes by running through Kimwipes until these came through without stains, partly with a previous soaking step
- Dry
- Alcohol wipe
- Wrapping in plastic

Later on, the major shipment of small joints and field cage coupling arrived, which were difficult to clean due to their small inner tube diameter of 1 inch. Additionally they were not deburred (see Figure 14). For the small parts, a small ultrasonic bath was found useful for cleaning (see Figure 15), and we just recall the procedure here:

- Pre-rinse in tap water, wipe of big dirt flakes with hand, see the difference in Figure 16 and 17
- 1st sonic bath wash, heated distilled water with two percent Citranox, simple-green or some acceptable detergent. (15 minutes = max allowed time on bath timer, see Figure 18)
- Rinse with distilled water in a bucket, wipe with kimwipes
- 2nd sonic bath wash, heated distilled water w/cleaner detergent(15 minutes) (new solution needed)
- Final rinse, 2x with distilled water (no sonic, just 2 buckets)



Figure 14: Deburring of field cage L-bows.



Figure 15: Sonic bath tests.



Figure 16: L-bow before manual removal of grease and dirt.



Figure 17: L-bow after manual removal of grease and dirt



Figure 18: Ultrasonic bath with heated two percent Citronox solution.



Figure 19: Drying of the couplings.

- Dry, see Figure 19

The second large shipment of parts for cleaning was coming after the Cathode and Anode frame parts were cleaned, and partly assembled. These included the field cage tubes and their couplings. The field cage tubes itself came unfortunately very dirty and as they had a lot of holes to improve the Argon flow in the later built TPC, these holes had been not deburred, thus an additional deburring step had to be introduced before the cleaning of

the pipes. A dedicated cleaning station was setup, to handle the large amount of pipes (see Figure 20).

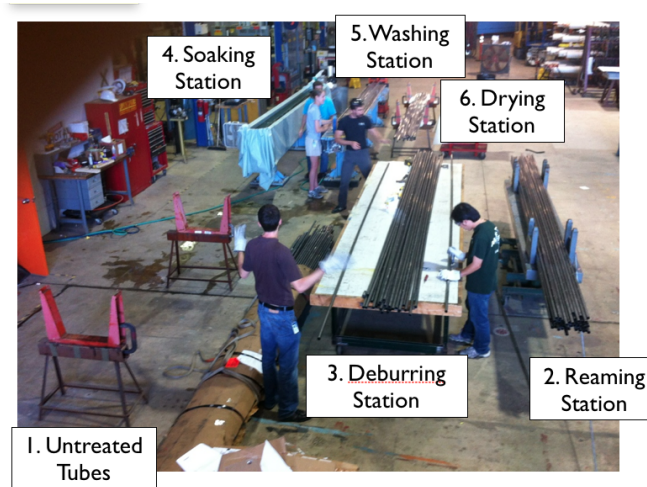


Figure 20: Fieldtube cleaning station.

As mentioned, a lot of deburring of parts was needed, we found out that a pre-reaming with a large metall stave eased the strength one had to invest in the deburring a lot. Thus, the cleaning procedure is became the following:

- Reaming the pipes with a metall stave (see Figure 21)
- Deburring of the pipes (see Figure 22)
- Soaking of the pipes in simple green solution with water flow (see Figure 23 and 24)
- Cleaning of the outside with Scotchbrite and Simple Green solution
- Rinse with water, see Figure 25
- Cleaning of the inner pipes by running through Kimwipes, attahced on a snake, until these came through without stains,see Figure 26
- Rinse with water
- Dry
- Alcohol wipe, see Figure 27
- Wrapping in plastic, see Figure 28



Figure 21: Reaming of the pipes.



Figure 22: Deburring of the pipe holes.



Figure 23: Soaking of the pipes.



Figure 24: Water flow provision.



Figure 25: Rinse of the pipes.



Figure 26: Snake with Kimwipe.



Figure 27: Alcohol rub.



Figure 28: Wrapping.

The G10 parts were first cleaned with brushes. While this worked well for the very small parts, we encountered trouble for the large field cage support bars and cross bracings (see Figure 29), the cutted corners always showed a large fraction of a white powder-like substance after drying, due to the flaking of the glas fiber material. Thus it was decided to use a sonic bath for cleaning.



Figure 29: G10 parts.



Figure 30: Pre Cleaning station.



Figure 31: Rinsing after pre wash with a water jet.



Figure 32: Sonic bath with two percent solution of Elma Clean 65.

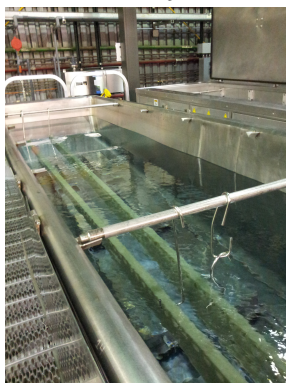


Figure 33: Sonic bath with de-ionized water.



Figure 34: Drying and packing of the G10.

The G10 parts were cleaned at the ultrasonic baths of the Fermilab Accelerator Division (contact person Scott McCormick). Their cleaning station procedure from their experience on metallic parts was adapted as follows:

- Pre-Clean of all parts with tap water and a standard cleaning detergent to remove all larger dust and oil remainings, see Figure 30
- Large pressure water jet rinse, see Figure 31
- Ultrasonic bath with a 2% solution of Elma Clean 65, 10min with at 110 degree Fahrenheit, with high power ultrasonic, see Figure 32
- Rinse with de-ionized water
- Ultrasonic bath in de-ionized water, 15min, medium power, see Figure 33
- Ultrasonic bath in de-ionized water, 10min with at 110 degree Fahrenheit, with high power ultrasonic
- Dry with clean nitrogen gas
- Wrapping in plastic, see Figure 34

Afterwards, the G10 parts were baked for about 24 hours in an oven at 60° celsius.

Suggestions for future large LAr TPC's

From the experience we gained in the cleaning of the many parts of the TPC, we can recommend the following improvements for future detectors:

- Always request that metal parts are deburred
- Clear labeling of parts, especially when similar parts exists
- Do not weld pipes shut on ends before a first cleansing of the inside could be done
- Do not use G10, use Peak or Pie, even when its more expensive
- Think about the weight of parts, 2inch thick steel beams of 2.4 m have a weight far too heavy for 2 person to carry and rotate during cleaning easily
- Sugested cleaning procedure for future:
 - Pre-soak in cleaning detergent, rough scrubbing to remove larger flakes left from drilling holes
 - Run a steam hose through pipes
 - Large pressure water jet rinse and/or hose for pipes
 - Ultrasonic bath cleaning with Simple Green or Citronox solution (AD up to 7 feet pieces, or custom build a new station)
 - Rinse with de-ionized water
 - Ultrasonic bath in de-ionized water
 - Dry with Nitrogen gas
 - Wrap in Plastic
- It is worth to organise a huge ultrasonic bath for large pieces, especially pipes or beams
- For thin pipes, the application of a high pressure steam hose was suggested by Fermilab AD personal