

NLS2017096  
Enclosure 2

**Enclosure 2**

CNS-ER-2017-053  
"SSST Bus Inspection Report"



Entergy

NUCLEAR  
MANAGEMENT  
MANUAL

QUALITY RELATED

3-EN-DC-147

REV. 5C1

INFORMATIONAL USE

PAGE 11 of 17

Engineering Reports

ATTACHMENT 9.1

ENGINEERING REPORT COVER SHEET & INSTRUCTIONS

SHEET 1 OF 1

Engineering Report No.

2017-053

Rev 0

Page 1 of 17

Engineering Report Cover Sheet

Engineering Report Title:

Startup Station Service Transformer (SSST) Bus Inspection Report

Engineering Report Type: (3)

New

Revision

Cancelled

Superseded

Superseded by: \_\_\_\_\_

ECR No. N/A EC No. N/A

(4) Report Origin:  CNS  Vendor

Vendor Document No.: \_\_\_\_\_

(5) Quality-Related:  Yes  No

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Date: 10/26/2017

Design Verified: Not Required  
Design Verifier (if required) (Print Name/Sign)

Date: \_\_\_\_\_

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Date: 10/27/2017

## **Executive Summary**

On the week of September 25<sup>th</sup>, 2017, Cooper Nuclear Station (CNS) performed an inspection of the two 4160V, non-segregated buses that delivers power from the Startup Station Service Transformer (SSST) to the four non-safety-related switchgears, A, B, C, and D. The inspection was performed per Preventative Maintenance work order 5069489 which is performed on a ten year frequency. The inspection includes a visual inspection of the buses insulation, bus connections and structures. The inspection also performs Hi-Pot testing and Low-Resistance testing to further validate that the bus is isolated from ground and that all the bolted connections are in acceptable condition. Based on the inspection results it is concluded that the SSST buses are in an acceptable condition with only minor issues identified, none of which threatened the buses ability to perform their function. Any defect found that was deemed to be more than superficial was repaired per work order 5203744.

## **Brief System Description**

The inspected bus delivers backup power to the plants non-safety-related buses from the SSST. The SSST is a four winding transformer which is able to supply power to two separate buses, the X-winding and Y-winding. The SSST X-Winding provides 4160V backup power to the A and B buses and is rated for 3000 amps. These buses automatically transfer to the SSST after a plant trip. The SSST Y-Winding provides 4160V backup power to the C and D buses. The C and D buses do not automatically transfer to the SSST and are only aligned to the transformer by operator action. The only loads on the C and D buses are the Reactor Recirculation Motor-Generation (RRMG) Sets. RRMG A can be fed from the C switchgear and RRMG B can be fed from the D switchgear. Normally only one RRMG is on the SSST while the other is being fed from the Normal Station Service Transformer (NSST). This is done to prevent the loss of both RRMGs after a plant trip.

## **Detailed Inspection Results**

As a result of the inspection eleven (11) condition reports were generated that documented thirty-one (31) identified issues. Attachment 1 provides details for each of the condition reports.

During the bus inspection the requirement for the bus condition is that the bus be free from unacceptable indications of surface anomalies, which suggests that conductor insulation degradation exists. In addition, no unacceptable indication of corrosion, cracks, foreign debris, excessive dust buildup, or evidence of moisture intrusion will exist. An unacceptable indication is defined as a noted condition or situation that, if left unmanaged, could lead to a loss of intended function. None of the indications identified were deemed as detrimental to the bus

or would have caused short-term failure. With that said all indications with any appreciable depth into the insulation were repaired using shrink tape.

A majority of the issues identified in the condition reports were mechanical damage. The most common cause of mechanical damage is past maintenance activities. Mechanical damage results in gouged or cut insulation from the installation of support pieces or tool marks. Damage from corona discharge was also identified on the bus. A majority of the corona discharge damage was in the form of discoloration. As long as there was no appreciable depth to the corona damage and only discoloration was present cleaning using an alcohol-based cleaner was the only action necessary. CR-CNS-2017-05788 in Attachment 1 is an example of this type of condition. Per the 3M datasheet (CNS Vendor Manual 0233) for the installed insulation the material has a dielectric strength of 550 V/mil. For the CNS application the thickness of the shrunken insulation is approximately 50 mils. Technically the insulation would be sufficient to perform its function with penetration greater than 50% into the insulation ( $25 \text{ mils} \times 550 \text{ V/mil} = 13,750 \text{ volts}$ ) since the bus is operated at 4160 VAC. Minor surface abrasions and discoloration have an insignificant impact to the insulations dielectric properties. Small movement in the bus bars due to thermal expansion and contraction could be a cause of some minor abrasions due to the expansion coefficient for aluminum which is approximately  $13 \times 10^{-6} \text{ in}/(\text{in}^{\circ}\text{F})$ . The longest individual bus bars in all the buses are 8 feet which are bolted together. The longest run above the Turbine Building railroad door is approximately 80 ft per drawing 0109D4798 sheet 2. For a 30 degree F rise in temperature, the expected expansion of the bus bar would only be approximately 3/8 of an inch. The thickness of the insulation is sufficient to provide the required insulation value with minor abrasions, whether caused by expansion and contraction or the removal and reinstallation of the supports. Any spots of corona discharge that contained a more than superficial depth were conservatively shrink tape repaired. 3M was contacted (3M Application Engineer Gary Slater) and confirmed that the insulation is over built and that minor surface damage does not impact the insulation ratings since adequate thickness remains. As such, minor surface discolorations do not require repair. The insulation was tested with a Hi-pot prior to being returned to service.

The supports were also inspected for signs of damage and/or tracking. There were no signs of tracking identified. There were conditions identified where the supports were not adjusted correctly. In those situations the supports were replaced and properly fitted. A question was asked about some Glastic supports being too tight against the insulated bus bars. The tighter the support is to a bus bar the less likely corona damage will occur; therefore, the tightness of the Glastic support is not an issue. Areas with large gaps and indications of corona could be enhanced with the addition of a silicone grommet between the support and the bus bar to minimize the air gap, although this is not required by the design of the bus. Grommets were not installed based on the limited corona observed during the inspection of these buses. There

is enough flexibility in the Glastic supports to accommodate the small movement (approximately 3/8 inch over 80 feet) of the bus due to thermal cycling. The insulation supplier, 3M indicated that it is acceptable for the abrasion resistant insulation to be in contact with the supports. As such, the supports that appear to snugly fit the insulation are acceptable due to the thickness of the insulation and limited movement of the bars.

As stated previously a structural inspection is also performed per this preventive maintenance plan. There was one condition report written to document pitting and a thru-hole in a SSST duct cover (reference CR-CNS-2017-05784 in Attachment 1). A weld repair was performed on this cover.

The remainder of condition reports written to document issues that were identified and addressed during the inspection are documented in Attachment 1.

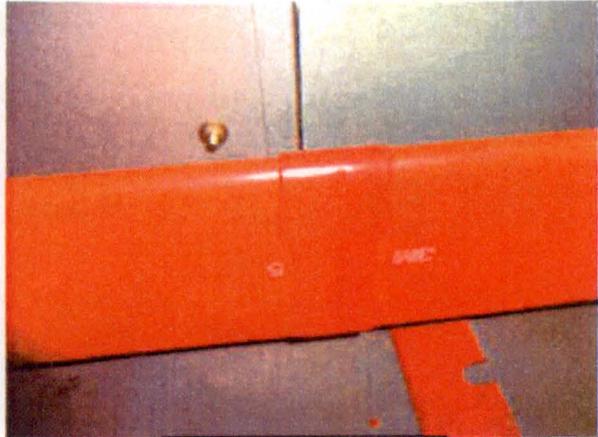
The ESST bus was insulated in 1993, inspected in 2005 and again in 2015. The SSST buses were insulated in 1995, inspected in 2009 and again in 2017. The SSST buses inspected in 2017 compared to the ESST bus that failed in January 2017 do not exhibit any signs of tracking along the supports which was found on the ESST supports. Additionally, the corona discoloration found is significantly less than that observed on the ESST insulation in 2017. The supports were found clean with no indication of tracking. As such, the condition of the insulation and supports indicate that the buses will remain serviceable until the next scheduled bus inspection, currently scheduled for 2027.

CR-CNS-2017-05764

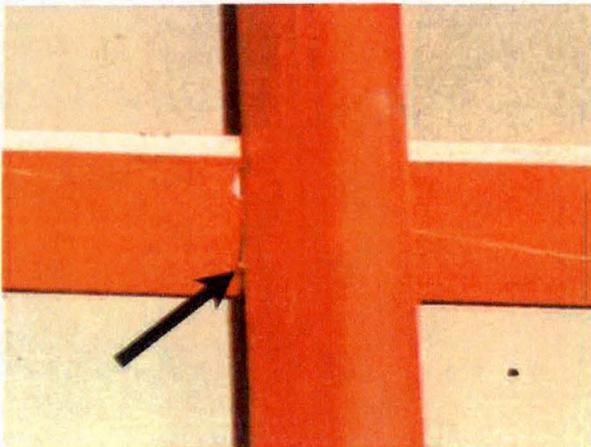
Six areas of minor insulation mechanical damage were identified on the SSST Y-winding (2000A) and X-Winding (3000A) non-segregated bus located in the non-critical switchgear room. The first two sets of pictures are from the Y-winding, the rest are from the X-winding. All six areas were repaired.



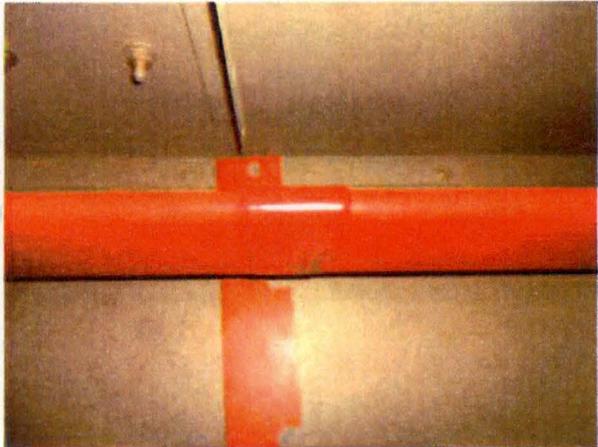
As-Found (y-winding)



As-Left (y-winding)

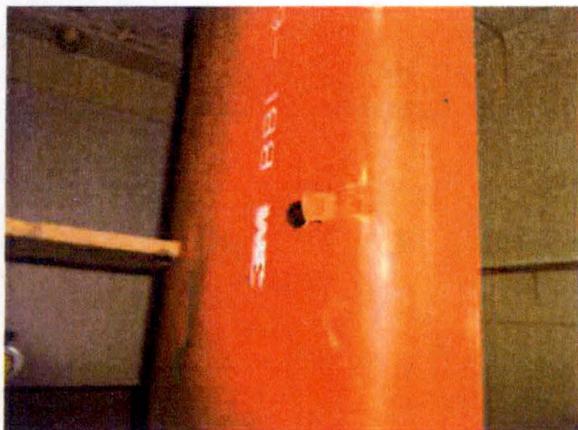


As-Found (y-winding)



As-Left (y-winding)

Attachment 1



As-Found



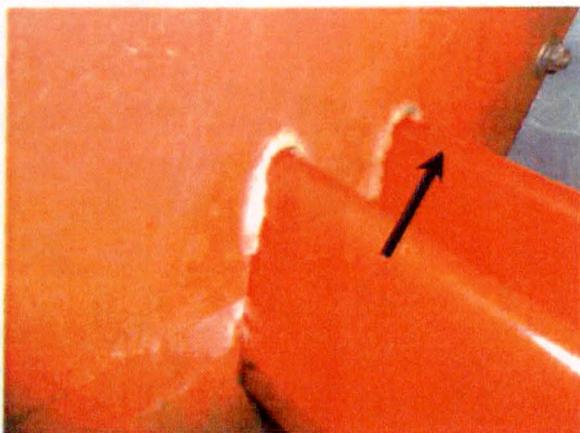
As-Left



As-Found



As-Left

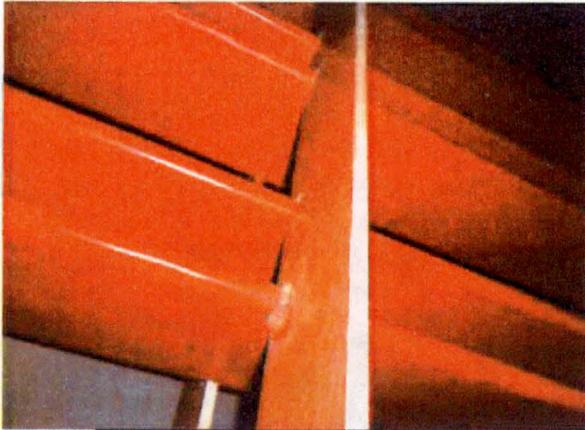


As-Found



As-Left

Attachment 1



As-Found



As-Left

CR-CNS-2017-05766

This condition report identified an oily film on portions of the X-winding (3000A) non-segregated bus insulation, located in the non-critical switchgear room. Film was cleaned off by Maintenance. The oily film was first identified in 2005 and was sent to Southwest Research Laboratory (SWRI) in 2005 for analysis. SWRI (SWRI Project 11817.06.001, Task Order #051025-3, SRR #28187) identified the substance using a Fourier Transform Infrared Spectrophotometer (FTIR). The substance was identified as a "polyethyl acrylate type material". Polyethylene compounds are considered to be good electrical insulators but a quantifiable resistance value cannot be identified. Hi-pot testing results from the previous hi-pot test performed per WO 5178820 on June 6, 2017 when the varnish was still on the bus demonstrates that the residual varnish's conductivity is acceptable when present on the insulation. See CR-CNS-2017-05790 below for examples of the identified condition and the results of it being cleaned off.

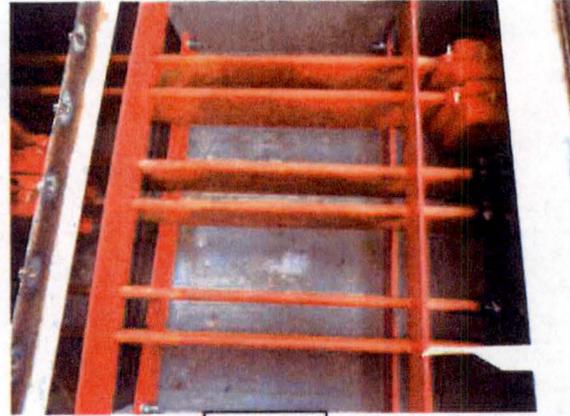
CR-CNS-2017-05780

The existing bus supports in a section of the SSST X-Winding east of the transformer, were not adequately supporting the bus. The notches in the supports were such that they were larger than normal gap between the bus and the supports.

Attachment 1



As-Found



As-Left

CR-CNS-2017-05783

On the SSST, X-Winding bus some bird droppings were found in the area just North of the expansion boot. The bird droppings appear to be residual from an expansion boot that was found degraded several years ago and since replaced per work order 4442920. The area was cleaned by hand.



As-Found



As-Left

Attachment 1

CR-CNS-2017-05784

A top cover on the SSST, X-winding (3,000 amp) non-segregated bus located on the bottom of the north vertical run (90 degree) is pitted with one location that has a through hole.



As-Found

CR-CNS-2017-05786

The X-winding bus had two bus supports that were missing. The section located directly to the south of the expansion boot was missing two bottom bus supports. New bus supports were installed per work order 5203744. There are no pictures of this condition

CR-CNS-2017-05787

This CR identified that a portion of bus was exposed at the bottom of a 90 degree turn. This was caused by the 90 degree boot sagging and exposing the bus. The exposed bus was covered with shrink tape. No as-left picture was available.



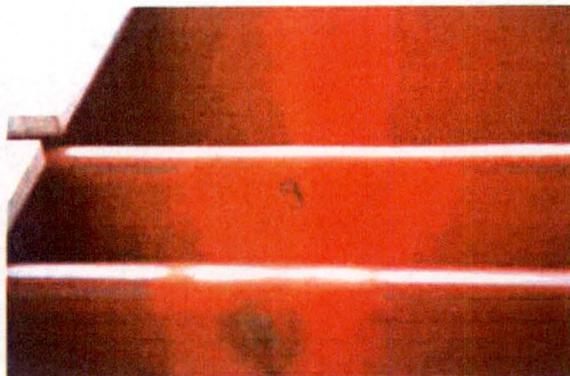
As-Found

CR-CNS-2017-05788

On the X-Winding bus located on the horizontal section on north end of run above railroad door, signs of surface corona discharge damage were identified. This was cleaned per 7.3.41. The corona damage and the cleaning are shown in the pictures below. In addition, a minor nick was seen in the insulation by the bottom support. The nick was repaired by shrink tape. There is no picture of the tape repair.



As-Found



As-Left

On the X-winding horizontal bus above railroad door, one spot where a nick was present in the bus insulation was identified. This item was shrink tape repaired.



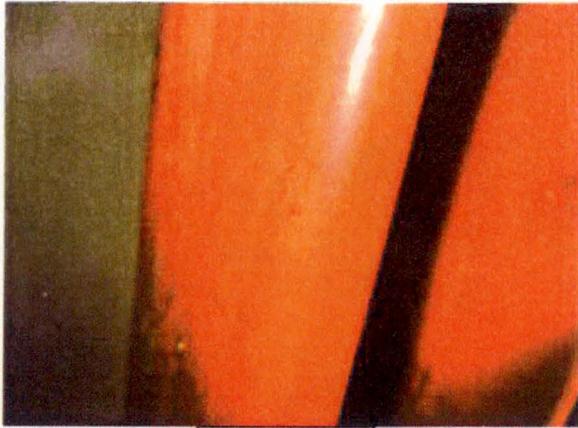
As-Found



As-Left

On the X-winding, south vertical run, there were three (3) spots where nicks were found in the insulation. All three were shrink tape repaired.

Attachment 1



As-Found



As-Left



As-Found



As-Left



As-Found



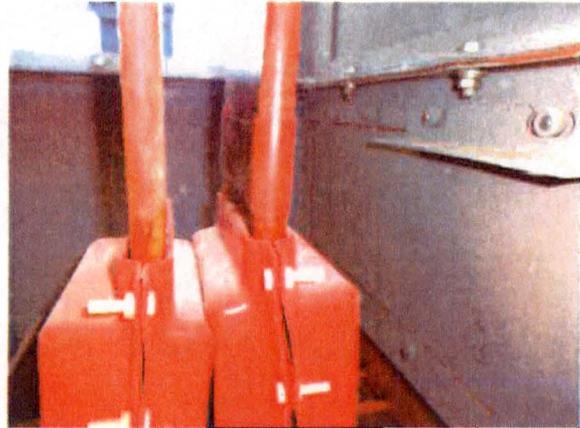
As-Left

Attachment 1

One nick was found in the X-winding bus insulation directly east of the SSST. This was shrink tape repaired.



As-Found



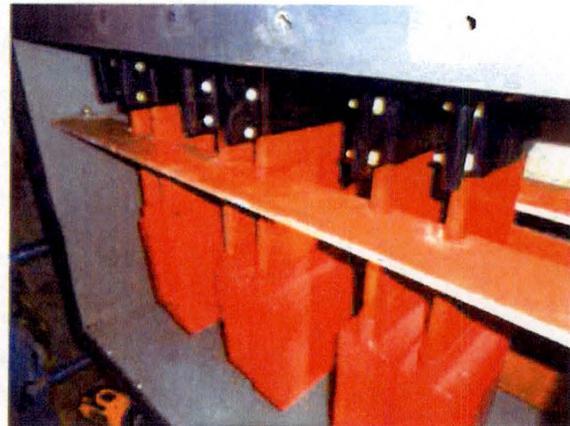
As-Left

CR-CNS-2017-05790

On the X-winding bus corner section on the run just before the south vertical section a nick in the insulation on the middle phase was identified. This was shrink tape repaired



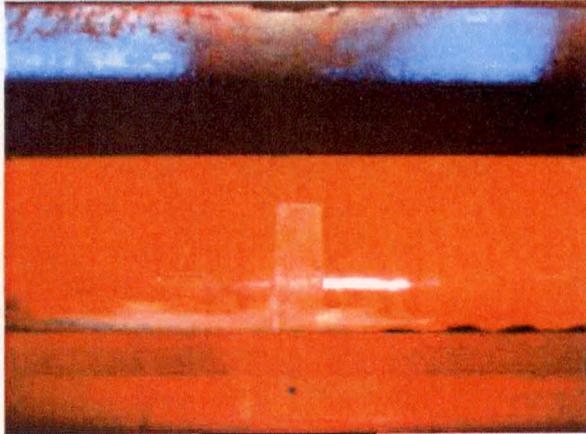
As-Found



As-Left

On the X-winding, the section just before the south vertical run, nicks were found in the insulation on the middle and east phases. These were shrink tape repaired.

Attachment 1



As-Found



As-Found



As-Left

On the X-winding bus, located 2 covers to the south of the south vertical section, a gouge in the insulation on the west phase of the bus was identified. This was shrink tape repaired.

Attachment 1



As-Found



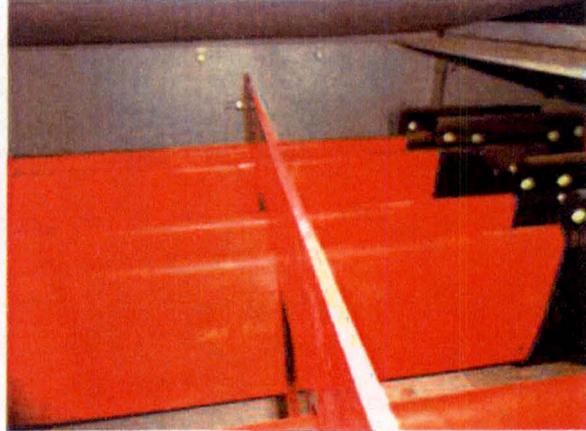
As-Left

CR-CNS-2017-05791

Three top bus supports on the X-winding bus were not providing adequate support. The subject bus supports were located north of the SSST just before the south vertical section. New bus supports were installed correctly.



As-Found

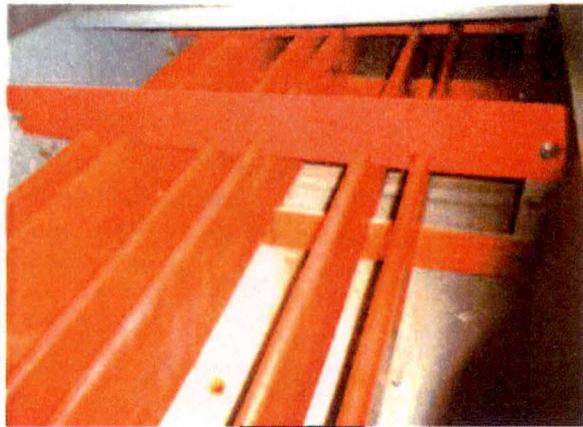


As-Left

Attachment 1



As-Found



As-Left



As-Found



As-Left

Attachment 1

CR-CNS-2017-06310

This condition report was written twenty-six days after the actual inspection. It was identified that the work order confirmations did not match the procedure discrepancies list or condition reports written. This condition report identified eight additional spots which required either repair and/or cleaning. These spots are mostly mechanical damage with some corona damage spots. All the spots were considered minor in nature but were conservatively repaired. The last picture only has an as-found picture. The condition identified in that picture only needed to be cleaned.



As-Found

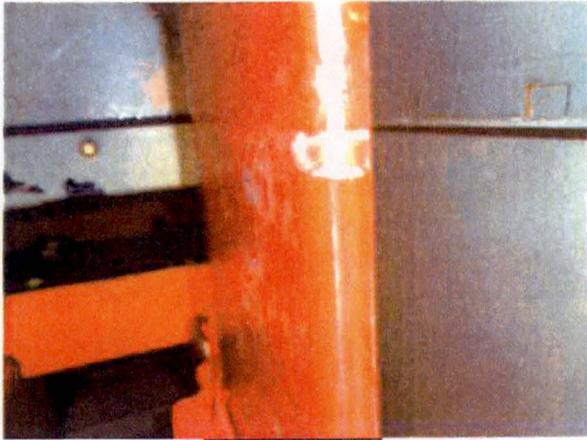


As-Found



As-Left

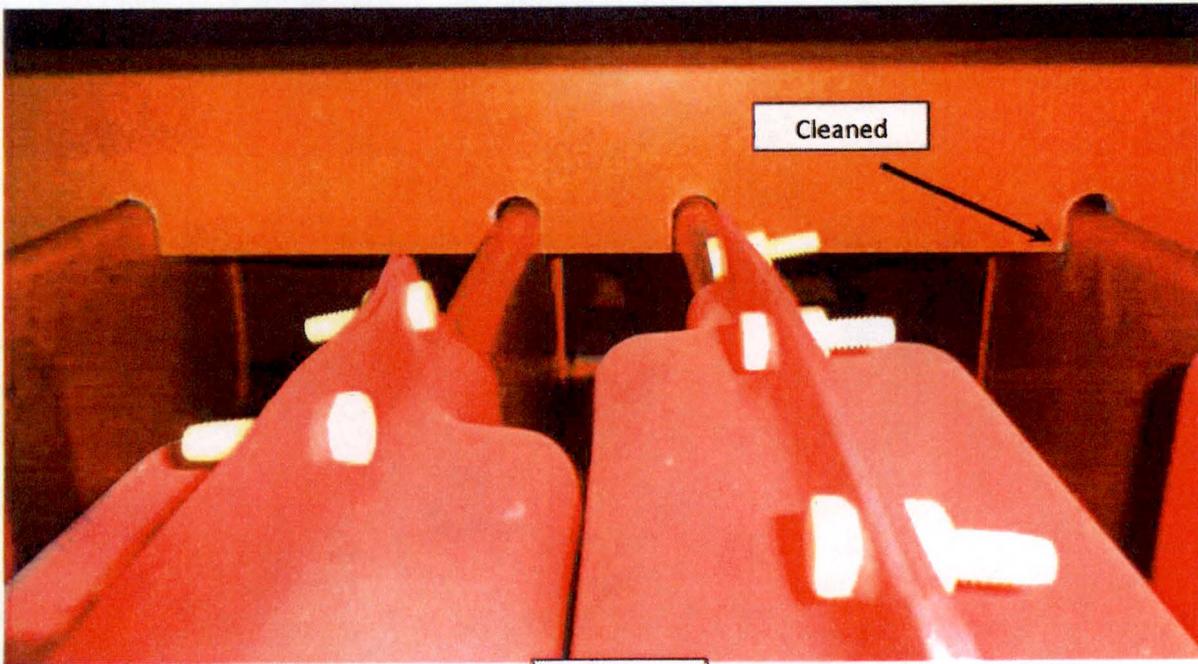
Attachment 1



As-Found



As-Left



As-Found

Cleaned