Static Control for Legacy Lines

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Electrostatic Answers

ABSTRACT

Static sparks shock operators, damage machine control systems, ignite flammable vapors, and change the surface chemistry of carefully formulated products. Static charges attract contaminants and cause coating non-uniformities. Prevent injury and waste from static electricity on legacy lines (existing machines) by improving static control using 4 steps.

1. Identify sensitive operations where static causes problems (solvent coaters, winding rolls).
2. Find sources of static charging by completing a static survey.
3. Install static dissipators to protect sensitivity areas and to dissipate static from known sources.
4. Implement maintenance and verification procedures to maintain good static control.

1. INTRODUCTION

Problems caused by static charges including shocks to operators, damage to machine control systems, ignition of flammable solvent vapors and product damage are largely preventable. Controlling static in web conveyance operations has been a challenge at least since the 1906 when a static bar using grounded pins was claimed for use in a printing press [1]. Historically, high risk areas in our facilities such as solvent coating enclosures have been protected by static dissipaters, which are normally effective. While good static control may be included in the design of new systems, often our challenge is to improve static control of legacy lines or existing equipment.

Describe here is a systematic, orderly process for evaluating the static performance of an existing system having 4 steps.

1.1 Identify static sensitive operations.

1.2 Find charging sources with a static survey.

1.3 Install static dissipators to:

a. protect sensitive operations, and

b. dissipate static at the source.

1.4 Implement maintenance and verification procedures.

2. IDENTIFY STATIC SENSITIVE OPERATION

Static sensitive operations such as solvent areas, solvent dryers, and winding rolls are where static charges put our operations or product quality at risk. A static spark in a solvent area may ignite flammable solvent vapors. Similarly, ignitions occur in dryers when air handlers fail or when a web crease carries excess solvent into the dryer. And static charges stored in winding rolls shocks operators and causes static problems at customer sites.

Use 2-layers of static control.

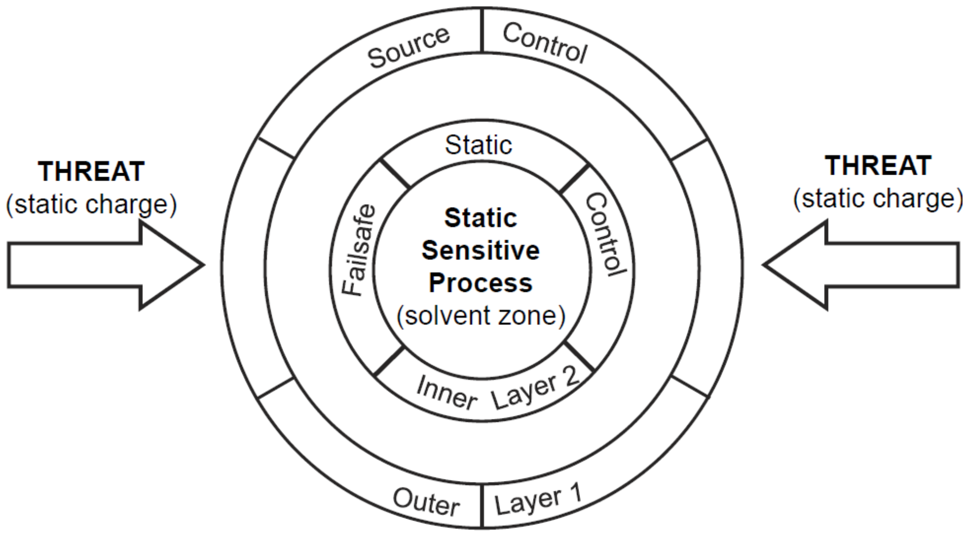


Figure 1: Two layers of static dissipaters protect risks from threats.

Effective static control in Figure 1 provides two layers of static protection for each static sensitive operation. Inner circle devices are located where webs enter risk areas and insure that sparks are suppressed in these protected area. Outer circle devices are located at the sources of static charging and insure that the web is charge free. With these two layers of protect, static sparks occur in protected areas only when there are two simultaneous faults or failures.

3. FIND CHARGING SOURCES WITH A STATIC SURVEY

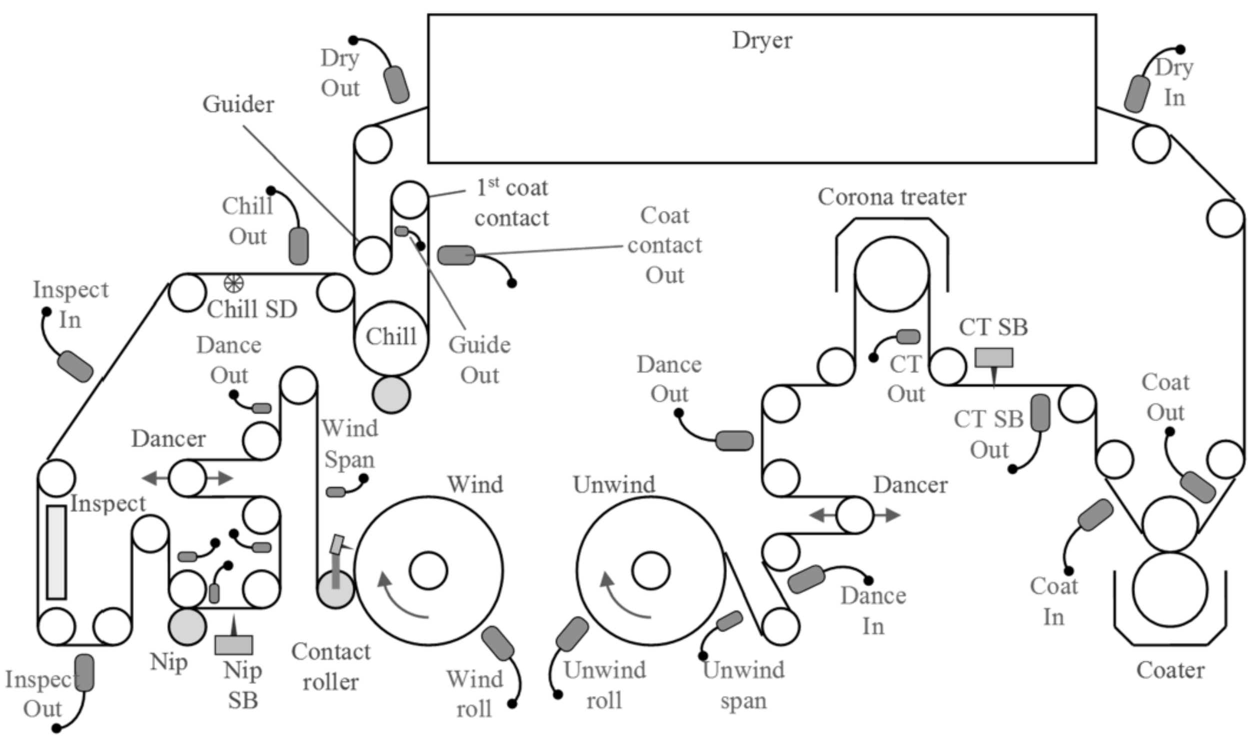


Figure 2: Measure the electric field on each accessible web span.

While identifying static sensitive areas of our processes is normally straight forward, finding the sources of static charging is challenging. Find sources of charge with a static survey. For example, measure the electric field on each accessible web span on the coater in Figure 2. Recorded in Table 3 are the minimum and maximum electric field readings for each span

Table 3: Electrostatic fieldmeter readings on each accessible web span

Electrostatic Fieldmeter Measurements				Date	10/21/2014	
#	Measurement Location	Min	Max	Average	Range	Shift
1	Unwind Roll	-3.0	-1.0	-2.0	2.0	#N/A
2	Unwind-Span	-0.5	0.0	-0.3	0.5	#N/A
3	Dance In	-0.8	-0.2	-0.5	0.6	-0.3
4	Dance Out	-1.2	-0.5	-0.9	0.7	-0.4
5	Corona Trt Out	5.0	9.0	7.0	4.0	7.9
6	Corona Trt SB Out	-0.4	0.0	-0.2	0.4	-7.2
7	Coat-In	-0.7	-0.4	-0.6	0.3	-0.4
8	Coat-Out	-0.4	0.2	-0.1	0.6	0.5
9	Dry-In	-0.6	0.0	-0.3	0.6	-0.2
10	Dry-Out	-6.0	-3.0	-4.5	3.0	-4.2
11	Guide-Out	-8.0	-5.0	-6.5	3.0	-2.0
12	Coat Contact-Out	4.0	6.0	5.0	2.0	11.5
13	Chill Out	6.0	8.0	7.0	2.0	2.0
14	Inspect In	1.0	2.0	1.5	1.0	-5.5
15	Inspect Out	0.5	1.5	1.0	1.0	-0.5
16	Nip In	0.0	1.0	0.5	1.0	-0.5
17	Nip Out	-4.0	-3.0	-3.5	1.0	-4.0
18	Nip SB out	-0.5	0.0	-0.3	0.5	3.3
19	Dance out	-1.5	-1.0	-1.3	0.5	-1.0
20	Wind Span	-1.8	-1.2	-1.5	0.6	-0.3
21	Wind Roll	-4.0	-2.0	-3.0	2.0	#N/A

Plot the average readings to get a good visual summary in Figure 4 of static performance. I use the "stop-light values" in Table 5 to assess static performance.

The first several readings near the unwinding roll are all in the low static, "Green Zone." The first two readings Unwinding Roll (-2.0 KV/cm) and Unwind-Span (-0.3 KV/cm) indicate that there is a low level of static charge stored on the unwinding roll.

And, readings Dance In (-0.5 KV/cm) and Dance Out (-0.9 KV/cm) show that the dancer roller adds only a small amount of negative static on the web.

Reading Corona Treater Out (+7.0 KV/cm) shows that the corona treated added a large amount of positive static to the web. And, reading Corona Treater Static Bar Out (-0.2 KV/cm) shows that the static be effectively dissipates static on the web from the corona treater.

Static on the web through coating in Figure 4 remains in the low static "Green Zone."

Reading Dry-Out (-4.5 KV/cm) shows that transport through the dryer adds a significant amount of static to the uncoated side of the web. And, reading Guide-Out (-6.5 KV/cm) shows that the guider roller near the dryer exit in Figure 2 adds a significant amount of static to the web. The plot of the average fieldmeter readings in Figure 4 shows clearly that static control near the dryer exit should be improved.

Reading Coat Contact-Out (+6.0 KV/cm) shows that the first idler roller that touched the freshly coated surface adds a large amount of positive static to the web. Reading Chill Out (+8.0 KV/cm) shows that the nip roller on the chill roller adds additional positive static. Figure 4 shows clearly that static control near the chill roller should be improved.

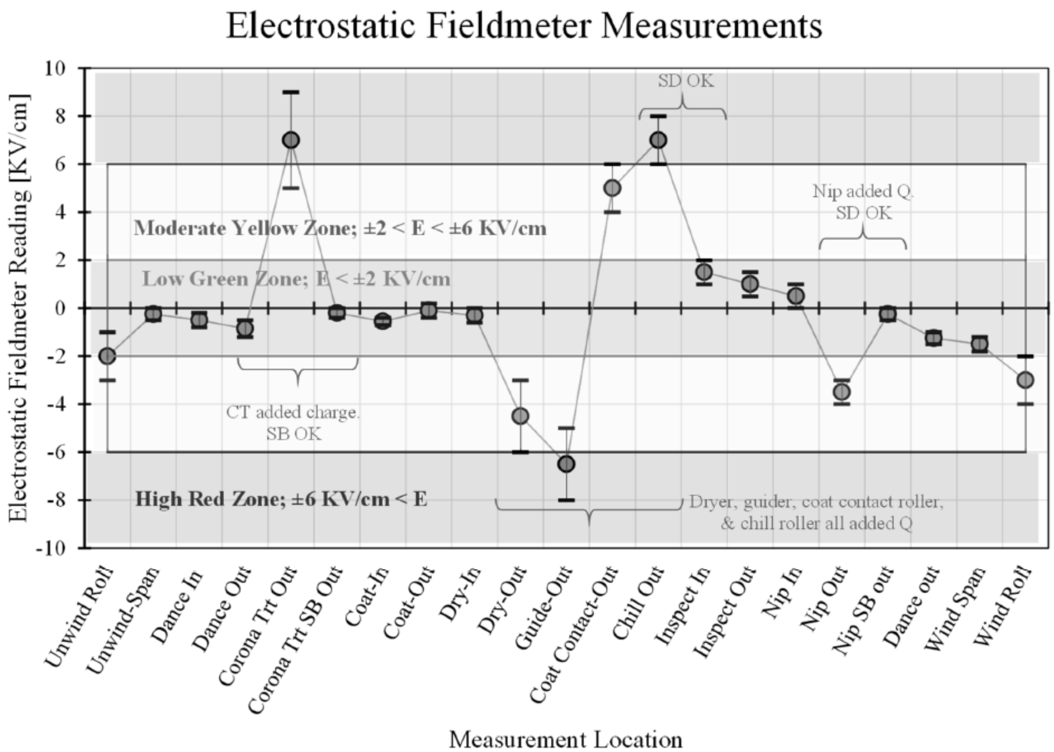


Figure 4: Plot the average readings to get a good visual summary of static performance.

Table 5: Electrostatic Fieldmeter "Stop-Light" values

Zone		Measured Level	Comments
Green	Low	E<±2 KV/cm	Static problems unlikely.
Yellow	Moderate	±2 < E < ±6 KV/cm	Static problems possible. Consider implementing static control improvements
Red	High	±6 KV/cm < E	High static. Static problems likely. Sparking occurs.

Reading Inspect In (+2.0 KV/cm) shows that static dissipator Chill SD dissipates most of the static charge added by the chill roller.

Readings Nip-In (+1.0 KV/cm) and Nip-Out (-3.0 KV/cm) show that the tension control nip near the winder adds a significant amount of negative static to the web. Reading Nip Static Bar Out shows that the static bar effectively dissipates the static on the web deposited by the nip roller.

Readings Dance Out (-1.0 KV/cm) and Wind Span (-1.2 KV/cm) show that the web enters the winding roll with a low level of negative static. And, reading Winding Roll (-3.0 KV/cm) confirms that the roll stores negative static even though the static bar on the winding roll keeps reading Winding Roll low.

Plotted in Figure 6 are the shifts in fieldmeter readings in Table 3 to identify sources of charging. In general, shift exceeding ±1 KV/cm warrant static control. For example, the third value in Figure 6, Corona Treater Out (+7.9 KV/cm) shows that the corona treater deposited a large amount of positive static on the web. And, the next value Corona Treater Static Bar Out (-7.2 KV/cm) shows that static bar Corona Treater Static Bar effectively dissipates the static on the web deposited by the corona treater.

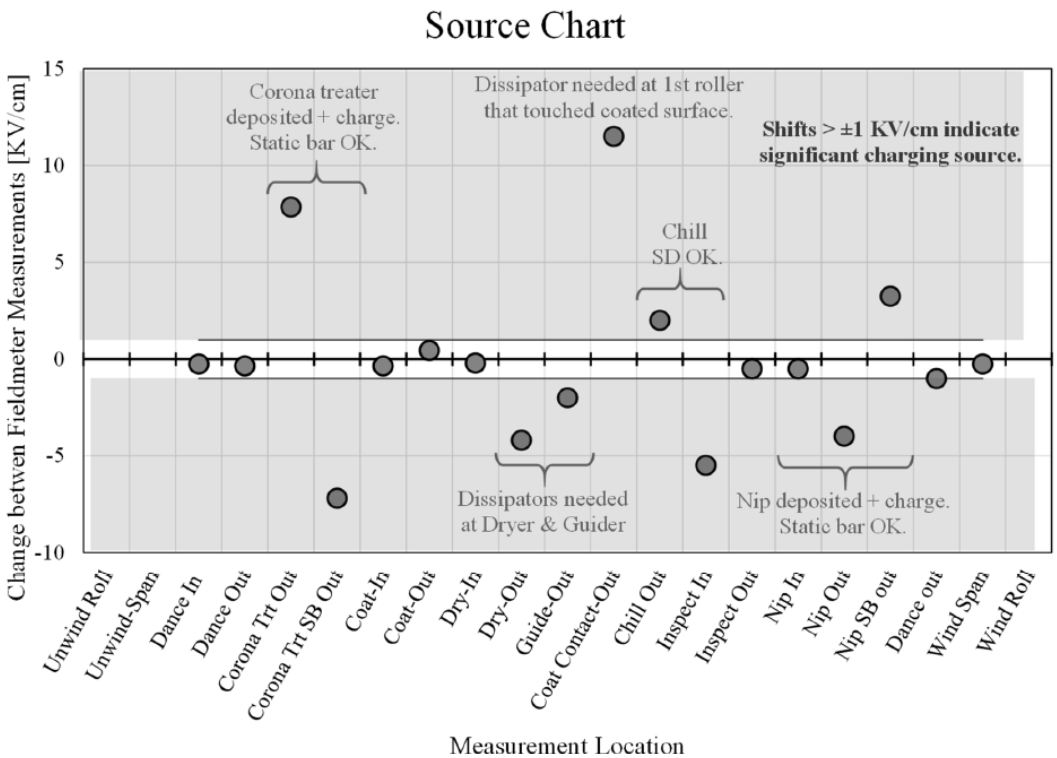


Figure 6: Plot the shift in the readings to identify sources of static charging.

Value Dry-Out (-4.2 KV/cm) shows that transport through the dryer adds a significant amount of negative static to the back side of the web. The best practice is to install an active static bar at the dryer exit facing the uncoated surface of the web that touched the idler rollers in the dryer.

Value Guide-Out (-2.0 KV/cm) shows that guide roller near the dry exit adds a significant amount of negative static to the web. A static dissipator should be installed on the web span exiting the guider roller facing the web surface that touched the roller.

Value Contact Coat-Out (+11.5 KV/cm) shows that the first idler roller that touched the freshly coated surface added a large amount of positive static to the web. A static dissipator should be installed on the web span exiting this roller facing the web surface that touched the roller.

Value Chill Out (+2.0 KV/cm) shows that the chill nip roller adds a significant amount of positive static to the web. Value Inspect In (-5.5 KV/cm) shows that the Chill Static Dissipator in Figure 2 adds a large amount of negative static to the uncoated surface of the web. While this dissipator is well placed to dissipate static from the chill nip roller, it also responds to the positive static on the web from the first idler roller that touched the freshly coated surface by depositing negative static on the wrong side. A static dissipator is needed on the web span exiting the first idler that touches the freshly coated surface.

Value Nip Out (-4.0 KV/cm) shows that the tension control nip near the winding roll deposits a significant amount of negative static on the web. And, value Nip Static Bar Out (+3.3 KV/cm) shows that the static bar dissipates most of this static.

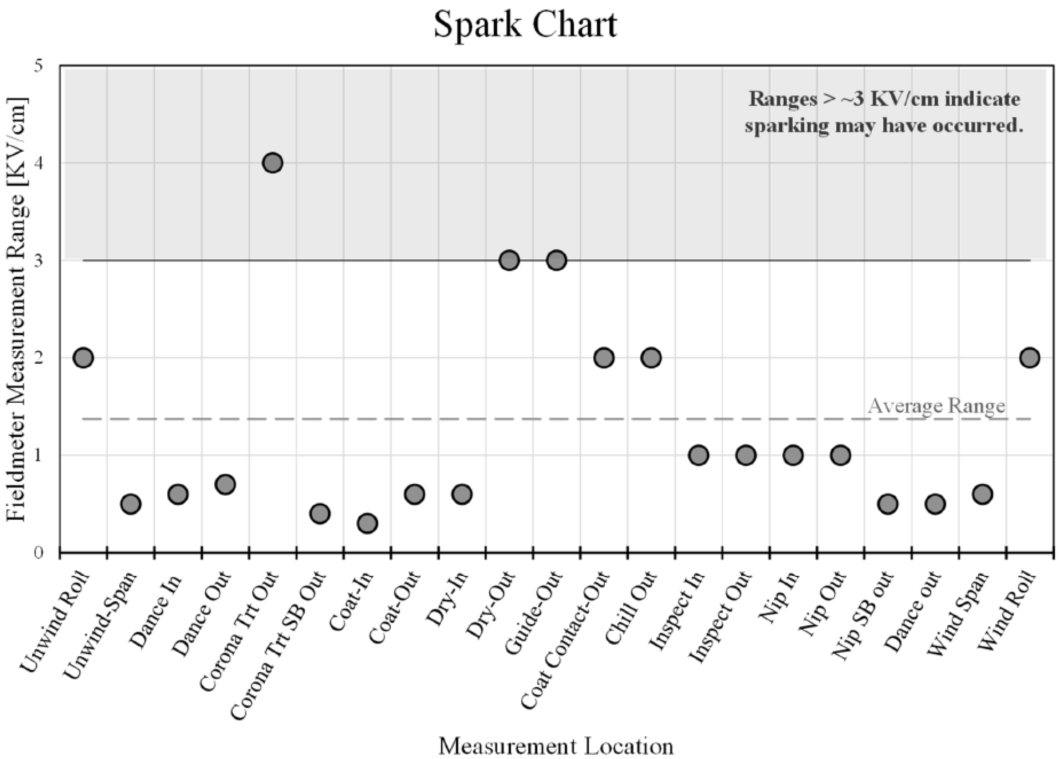


Figure 7: Plot the range of readings to find where sparks have occurred.

Plotting the range of the fieldmeter readings in Figure 7 helps identify where static sparks occur. Sparking occurs when the fieldmeter readings exceed about ±6 KV/cm. Initially, the static charges are deposited relatively uniformly on the by contact with nip rollers or perhaps by a corona treater. With uniform charge density, fieldmeter readings are relatively steady as the web moves past. However, when sparks occur, spots of opposite charge are deposited on the web. For example, the web exiting the corona treater in Figure 2 carried a high level of relatively uniform positive static. However, the level is so high that sparking occurs between the web and the nearest grounded object that is often the corona treater roller. These spark deposit spots or bands of negative static on the back side of the web exiting the corona treater. Consequently, the web exiting the corona treater has a large amount of relatively uniform positive static on the treated surface and many spots of negative charge on the back surface. The result is a high, average positive reading that is highly variable. The range of the Corona Treater Out reading indicates that sparking likely occurred between the web and the corona treater roller.

Figure 7 indicates that sparking likely occurred near the exit of the dryer and at the guide roller. Improving static control to lower the average fieldmeter reading should suppress sparking and lower the variability.

4. INSTALL STATIC DISSIPATORS

Install static dissipators to protect static sensitive processes and to dissipate static charges on web exiting charging sources. For example, static protection for the solvent coater in Figure 8 has 3 elements; inner circle static dissipator SB1, outer circle static dissipator SD2, and the static dissipative pressure roller.

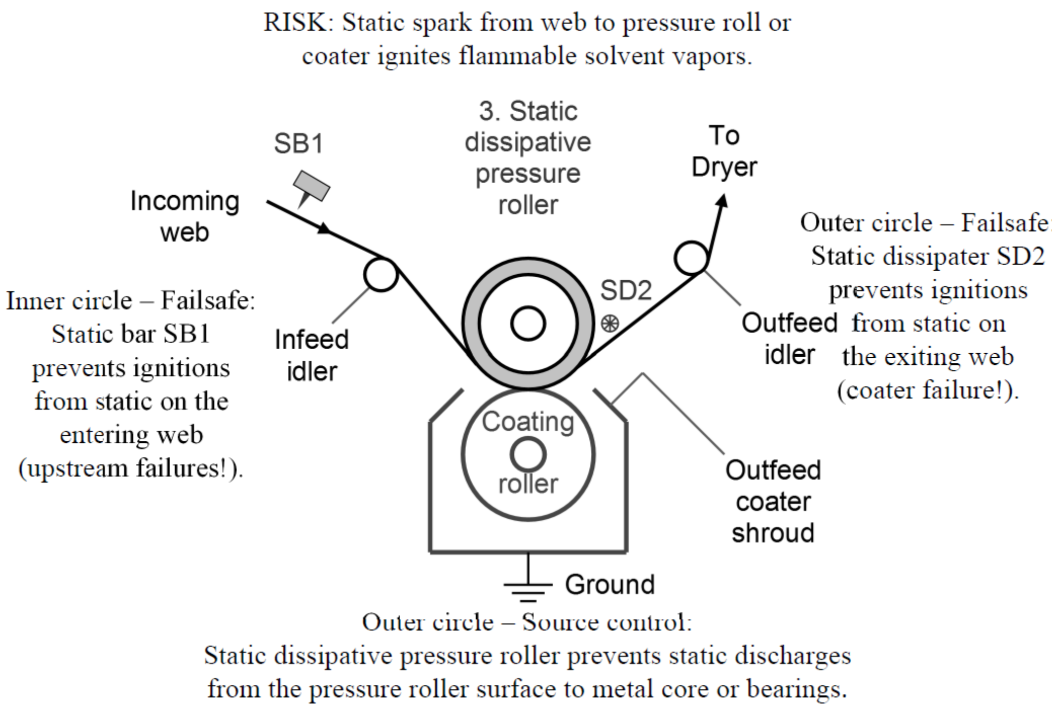


Figure 8: Static control for solvent coaters have 3 elements.

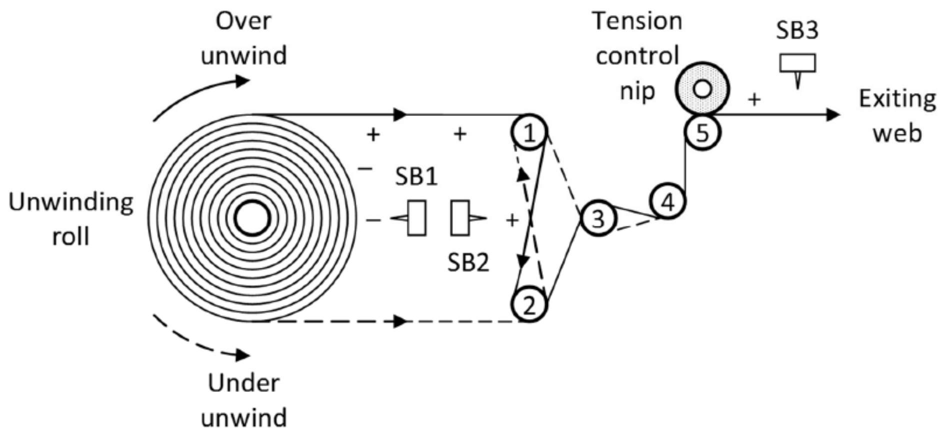
With effective upstream static control, the web entering the coater should be charge free. In the event of an upstream failure, inner circle static dissipator SB1 suppresses sparks in the solvent coater. Static dissipator SB1 should be an active static bar that monitors the static on the web, which is a relatively new capability of some static bars.

Static dissipator SD2 protects against charges deposited on the web by the coater. A few coating processes deposit significant amounts of static on the web such as gravure coating with electrostatic assist. And, several faults cause high static exiting the coater such as the failure of the solvent pump that allows the coater to run dry, or excessive pressure applied to the pressure roller.

High static charges on the web exiting the coating nip may cause sparks to the nearest conducting object. Static dissipator SD2 must be the nearest conducting object, so it must be closer to the coating nip than the outfeed coater shroud.

Outer circle devices dissipates static at the source. Static charges stored within the unwinding roll in Figure 9 are often significant and should be dissipated. Two static dissipaters are needed [1]. Static bar SB1 in Figure 9 dissipates static on the outside surface of the unwinding roll. This static bar should be a distance bar capable of dissipating static at least one radius from the bar, which is a feature of some new static bars.

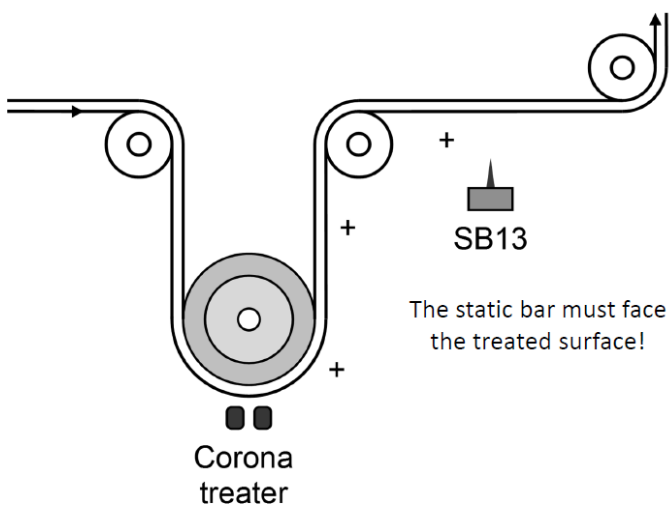
Static bar SB2 dissipates static on the inside surface of the web exiting the unwinding roll. Since SB2 is located past the first idler roller, it can be short range static bar. Note that SB1 and SB2 are positioned to effectively dissipate static on both sides of the web exiting the unwinding roll for either an over unwind direction or an under unwind direction.



Static is neutralized on both sides of the web exiting the unwinding roll.
Static bars SB1 & SB2 and idler rollers 1 – 5 are in fixed positions.
SB3 neutralizes static from the nip.

Figure 9: Two static bars dissipate static stored within the unwinding roll.
A third dissipator is needed at the exit of the tension control nip.

Static bar SB3 dissipates static from the tension control nip that is typically a significant charging source.



Static bar SB13 neutralizes charge on the treated surface from the corona treater.
Note that there are no static dissipaters on the webs prior to treatment.

Figure 10: Static bar SB13 dissipates static on the treated surface
of the web exiting the corona treater.

The corona treater in Figure 10 can deposit very large amounts of static charge on the treated surface. Static bar SB13 dissipates static on the treated surface of the web exiting the corona treater.

5. IMPLEMENT MATINENANCE AND VERIFICATION

Table 11: Maintenance and Verification Procedures

	Procedure	Comment
1	Fitness for use visual inspections	Quick visual inspection to verify that devices are in place, powered up, and ready for use.
2	Neutralization efficiency measurements	Periodic (monthly?) measurement to verify satisfactory operation.
3	Static surveys	Periodic (quarterly?) survey to verify that static is well controlled.
4	On-line static monitors	Real-time performance verification at a few, key positions.

Once effective static control is achieved on a legacy line, the maintenance and verification procedures in Table 11 insure future performance. Prior to starting a new job, walk the line with a checklist showing each static control device. Visually inspect each device to verify that it is fit for use. Each device is in place (not missing), which is a common fault for passive devices. Ionizing cords and tinsel may be easily broken by a web break or during the thread-up for a job. Passive devices removed to enable cleaning or to provide access may not have been re-installed. This quick, visual inspection will identify these problems before the job begins.

Static dissipators must be clean to function properly. Replace dirty or worn passive devices. Clean static bars according to the vendors instructions. Usually, the pins are cleaned with compressed air or with a brush.

Check to see that power is applied to active static bars. I am aware of at least two major static incidents where the root cause was that a critical active static bar was off.

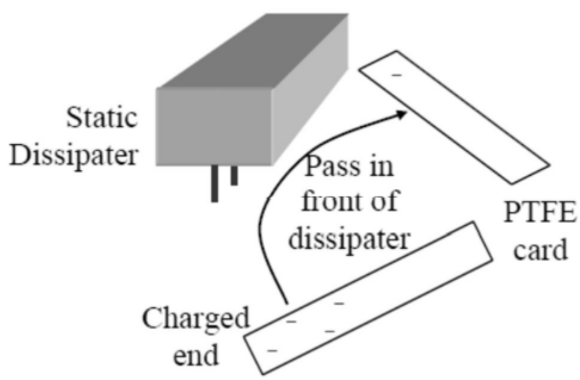


Figure 12: Test the neutralization efficiency of a static dissipator by measuring the reduction in static charge on a piece PTFE (of other polymer) using a hand held fieldmeter.

The quick visual inspection will enable many common faults to be restored prior to running a job. Periodically, the function of each static dissipater should be measured. Many modern static bars monitor their output current and provide a “clean” indicator when the current decreases below a threshold.

An alternative test is illustrated in Figure 12. Charge a piece of PTFE or some other insulating polymer by rubbing it with a cloth. Measure the initial charge density using a hand held electrostatic fieldmeter. The initial reading should exceed ±10 KV/cm. Pass the charged piece through the ion field of the dissipator, and again take a static reading. Passive dissipators in good condition should remove at least 80% of the static. Active dissipators that function properly should remove at least 90% of the static. Restore performance by replacing passive dissipators and cleaning active dissipators. After cleaning, re-test the active dissipator. If performance is unsatisfactory, replace the pins or replace the entire static bar.

After a major maintenance shut-down or to qualify a line for service, perform a static survey as in Figure 2. Analyze the readings as described in Section 3 to verify that static is well controlled.

Consider installing on-line static monitors in key locations in the process, such as exiting the unwind roll, exiting the coater, exiting the dryer, entering the winding roll, or on the winding roll. On-line static meters provide real-time verification that static levels are normal. Readings that deviate from normal often identify a problem before sparks occur.

Excellent static control may be achieved on legacy lines by (1) identifying static sensitive processes, (2) performing a static survey to identify charging sources, (3) installing static control devices to protect static sensitive processes and to dissipate static at the source, and (4) implementing maintenance and verification procedures to insure future performance.

6. REFERENCES

[1] K. Robinson, "Apparatus and Method for Neutralizing Static Charge on Both Sides of a Web Exiting an Unwinding Roll," US Patent Pub. No.: 2014/0078637 A1, Appl. No.: 13/621,291, filed 09/17/2012.