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Forensic Engineering Identification of Factors Impacting the Connectivity of the Air Tube to the Air Dome / Pressure Switch in Electrolux Washers

RE: *Sparks Landen vs Electrolux Home Products, Inc.*

Submitted to:

Hunton & Williams LLP
550 South Hope Street
Suite 2000
Los Angeles, CA 90071

Prof. Jahan Rasty, Ph.D., PE, MBA

May 22, 2014

I. Executive Summary

The main objective of this investigation was to identify potential variations in manufacturing, design and operating conditions of Electrolux-manufactured washing machines having an air dome and an air tube that are relevant to the likelihood of the air tube separating from the air dome and/or the pressure switch.

Inspection of 5 exemplar Electrolux-manufactured washing machines (FEX83IFS, FGX83IFS, FFLG2022MW, FFLE2022MW and FAHE4044MW) with an air dome and an air tube, as well as experimental tests conducted on these machines, resulted in the conclusion that there are a multitude of factors and mechanisms, with design manufacturing and/or operating variations within each mechanism, that either individually or in combination with each other, could affect the likelihood of whether the necessary conditions for separation of air tube from the air dome and/or pressure switch/transducer are met.

II. Scope of Work Performed

I was retained by the defense counsel to review the available case documents, including but not limited to critical review of assertions and conclusions reached by plaintiff that all Electrolux manufactured washing machines having an air tube and an air dome are substantially certain to overflow as a result of a common defect. Furthermore, I was given the task of determining the validity and credibility of the specific failure mode described by the plaintiff, i.e., separation of the air tube from the air dome and/or the pressure switch, and whether this failure mode can be scientifically and credibly attributed to a single common source identified by the plaintiff, i.e., insufficient air tube length and lack of strain-relief service loop and/or clamp in Electrolux washers that have an air tube and an air dome. In addition, five exemplar Electrolux-manufactured washing machines as shown in Figure 1 (FFLG2022MW and FFLE2022MW) and Figure 2 (FEX83IFS, FGX83IFS, FAHE4044MW) were to be examined and tested to identify all potential factors affecting the physical interaction of the air tube with the air dome and pressure switch that could influence the likelihood of the air tube disengaging from either the air tube or the pressure switch / transducer.

Figure 1 – Exemplar Frigidaire FFLG2022MW and FFLE2022MW Models Tested

Figure 2 – Exemplar Frigidaire FEX83IFS, FGX83IFS, FAHE4044MW Models Tested

The five exemplar machines tested in this investigations are referred to machine #1 through #5 as identified below:

Machine #1: Frigidaire Model # FEX83IFS
Machine #2: Frigidaire Model # FGX83IFS
Machine #3: Frigidaire Model # FFLG2022MW
Machine #4: Frigidaire Model # FFLE2022MW
Machine #5: Frigidaire Model # FAHE4044MW

III. Statement of Qualifications Related to Scope of Work Performed

My academic qualifications include bachelor, master, and doctoral degrees in Mechanical Engineering (LSU), as well as a master degree in business administration (Texas Tech). My areas of expertise within mechanical engineering that are pertinent to the technical issues discussed in this case include, but are not limited to materials science, stress analysis, mechanical design, forensic engineering, and root-cause failure analysis. I am a registered professional engineer (State of Texas), and have been involved in mechanical engineering and related work for the past 30 years in various capacities including industry, national R&D laboratories, national research foundations, and academia.

For the past 26+ years (since 1988), I have maintained continuous employment as a tenured professor at the department of Mechanical Engineering at Texas Tech University where I have taught 25 different courses at the graduate and undergraduate levels in the areas of materials science, metallurgy, manufacturing, design, solid mechanics, root-cause failure analysis and forensic engineering. I am the original developer of a course entitled "Principles of Failure Analysis and Forensic Engineering," which I have taught for the last 16 years at both graduate and undergraduate levels. The subject matters covered in this class include that are pertinent to technical issues discussed in this case include stress analysis, design, materials performance characterization, root-cause failure analysis techniques, and forensic engineering. I am also the director of the Materials Performance and Failure Analysis Laboratory at the Mechanical Engineering Department at Texas Tech University where I have been involved as the Principal and/or Co-Principal Investigator of more than $7.4 million in research grants from various industries, government agencies, national funding agencies, and national research laboratories.

Over the past 23+ years, I have also served as the president of Real-World Forensic Engineering, LLC, which is a consulting firm specializing in engineering consulting, forensic engineering, investigation of accidents, root-cause failure analysis, and intellectual property work. In this capacity, I have been involved in hundreds of engineering consulting and research projects in the above-mentioned areas. Several of my previous cases have been related to issues involving failure of components in consumer product, in particular home appliances including dish washers, washing machines, water heaters, heating furnaces, air conditioners and refrigerators. I have testified both in state and federal courts, as well as in depositions on behalf of both plaintiffs (60%) and defendants (40%).

Having personal knowledge of the facts in this case through the review of case documents, inspection, testing and collection of test data on 5 exemplar washing machine units having the same water level sensing and control system at issue in this case, research and discussions with Electrolux counsel and representative, and based on my education, training and aforementioned experience, I am qualified to render an expert opinion regarding the scope of work and case objectives as outlined in the previous section. Real-World Forensic Engineering, LLC is to be compensated for my time necessary for performing project-related tasks in this case at the rate of $395/hr. A list of my professional experience and scholarly publications can be found in my full CV as provided in the appendix of this report.

IV. Documents Reviewed

Court Documents

1. First Amended Class Action Complaint for Damages
2. Plaintiff's Rule 26 (A) (1) Initial Disclosures (Filed January 8, 2013)
3. Plaintiff's Response to Defendant Electrolux Home Products, Inc.'s First Set of Requests for Production of Documents (Filed January 8, 2013)
4. Plaintiff's Supplemental Response to Defendant Electrolux Home Products, Inc.'s First Set of Interrogatories
5. Defendant Electrolux Home Products, Inc.'s Responses to Plaintiff Sparks Landen's Special Interrogatories, Set One (Filed January 8, 2013)
6. United States Patent #5,107,706: Level Sensor Device for Household Appliances; dated April 28, 1992
7. Plaintiff's Supplemental Response to Defendant Electrolux Home Products, Inc.'s
8. First Set of Interrogatories
9. Proposed Order Granting Class Certification
10. Declaration of Jerome L. Ringler in Support of Plaintiff's Motion for Class Certification
11. Plaintiff's Notice of Motion and Motion for Class Certification
12. Request for Judicial Notice in Support of Motion for Class Certification
13. Declaration of Michael S. Rapkin in Support of Plaintiff's Motion for Class Certification
14. Declaration of Sparks Landen in Support of Plaintiff's Motion for Class Certification
15. Declaration of Catherine Burke Schimdt in Support of Plaintiff's Motion for Class Certification

Depositions

1. Transcript of Videotaped Deposition of Carl D. King, Electrolux Consultant, March 10, 2014

Additional Documents

1. Carlson's Appliances, Inc. Invoices
2. Vollmer-Gray Engineering Laboratories, Inc. Analysis
3. Diary Sheet File #58697 re State Farm claim
4. Wright Group Inc. Analysis of Washing Machine
5. Design drawings, Bates Documents: ELUX 00018-00112, 01003, 01004

V. Background

Electrolux Home Products, Inc. ("Electrolux") has distributed, manufactured, and/or sold top-loading washing machine and laundry centers including General Electric (GE), Kenmore, and Frigidaire branded appliances that have an air dome molded to the exterior vertical surface of the washing machine's tub near the bottom of the tub, and a length of flexible air tubing that connects the said air dome to a pressure switch, or depending on the particular model of washing machine, a transducer.

As the water level in a washing machine's the tub rises, the pressure of the rising water pushes the air within the air dome up the air tube towards the pressure switch/transducer, thereby increasing the force acting on components of the pressure switch / transducer. In machines equipped with a pressure switch, as the water level in the tub increases, the corresponding increasing force of the air pressure acting on the pressure switch diaphragm would eventually exceed a preset balancing force set by the user via selecting the desired water level setting in the control panel, that would result in sufficient distortion of the pressure switch diaphragm to complete an electrical circuit signaling the control module that the desired water level has been reached in order to stop the water pump from directing more water to the tub. In machines equipped with a transducer, instead of a pressure switch, increasing water level results in increasing pressure on transducer components that generate a corresponding increasing voltage (piezoelectric effect) that is sensed by machine's onboard electronic board as a signal for achieving predetermined water levels.

In order for the above water level sensing and control system to work properly, it is necessary that the continuity of the connection between the air dome, the air tube, and the pressure switch be preserved at their respective interfaces. Based on the review of available documents in this case, it has been alleged by the plaintiff that compromised connection at the interface of the air tube with the air dome and/or the pressure switch, occurs in all Electrolux washing machines due to insufficient length of the air tube and lack of strain relief, such as a "service loop" and/or a "clamp". The validity of plaintiff's hypothesis relies heavily on the erroneous assumption that the length of the air tube, as well as the presence or absence of a service loop and/or clamp, are the only controlling parameters governing the probability that the air tube in all Electrolux manufactured washing machines will disengage from either the air dome or the pressure switch. As discussed more fully below, multiple factors impact the question of whether the air tube in a particular washing machine is more or less likely to disconnect from the air dome and/or the pressure switch/transducer.

VI. Criterion for Air Tube Separation from Air Dome / Pressure Switch

In order for the air tube to separate and lose its connection at either the air dome or the pressure switch / transducer nipple, it is necessary that the resultant of all external forces acting on the air tube has a component "A" acting in a direction away from the nipple that exceeds the resultant of internal forces keeping the air tube connected to the nipple as shown schematically in Figure 3.

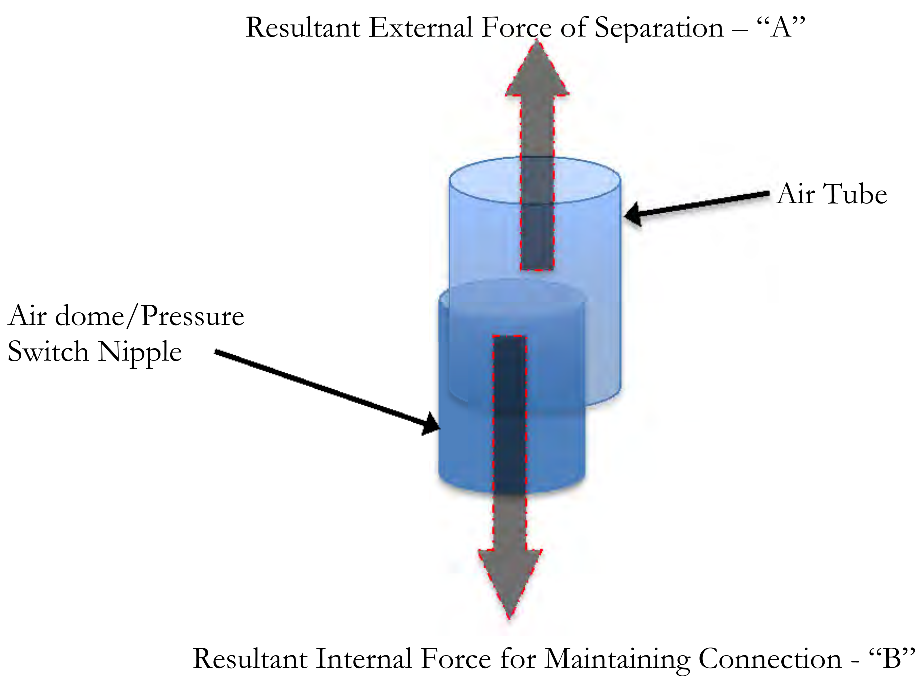


Figure 3 –Resultant external force "A" pulling the air tube away from the connecting nipple, and resultant internal connection force "B" between air tube and nipple. Loss of connection requires "A" to be greater than "B" (A>B).

Resultant External Force of Separation, "A", is the algebraic sum of the components of all external forces acting on the air tube in an outward direction parallel to the direction of the air dome/pressure switch nipple. So long as this resultant force is less than the resultant internal force of connection, "B", the air tube maintains its connection to the air dome/pressure switch. As such, the criterion governing the separation threshold of the air tube from the air dome/pressure switch requires that "A" be greater than "B", (A > B).

Although the above concept seems quite straightforward, improper identification of factors contributing to the magnitude and variations in the internal resultant force of connection (A), as well as improper identification of factors contributing to the magnitude and variations in the external forces of separation, can result in erroneous conclusions regarding whether the separation criterion A>B will be met for one group of Electrolux washing machines as compared to another group of Electrolux washing machines, due to the variations among the individual components that make up the resultant external force A, and the resultant internal force B. The following sections will describe in more detail the factors contributing to the resultant external separation force (A), as well as those contributing to the resultant internal connecting force (B), and sources of variability within each component.

VII. External Forces (A) and Sources Contributing to Potential Separation of Air Tube from Air Dome / Pressure Switch:

As stated above, the validity of plaintiff's hypothesis relies heavily on the erroneous assumption that the length of the air tube, as well as the presence or absence of a service loop and/or clamp, are the only controlling parameters governing the probability that the air tube in all Electrolux manufactured washing machines will disengage from either the air dome or the pressure switch. While it is conceivable that transmission of external operating forces to the air tube's connection point with the air dome or the pressure switch could be affected, either in a beneficial or adverse way, by the presence or absence of a strain relief service loop and/or a clamp, the plaintiff has made no attempt to address the variability in sources and magnitudes of external forces present in different groups of washing machines, and whether the external forces in all different design iterations of Electrolux machines are of large enough magnitude to meet the separation criterion discussed earlier.

After a thorough examination and testing of five exemplar Electrolux Washing Machines with an air tube connected at either end to an air dome and a pressure switch / transducer, the following factors were identified as potential sources contributing to the magnitude of the resultant external force of separation, i.e., the force pulling the air tube away from the air dome and the pressure switch/transducer. Any variations in the magnitude of any of the following sources can influence whether the resultant external force of separation would be strong enough to satisfy the separation criterion discussed earlier.

1. Air Tube Length

The air tube comes in 23 different length variations in order to accommodate different configurations and models of the machine. Electrolux part number 144617 (ELUX 00091), Revision "M", "TUBING", details the specific sizes of rubber tubing required by different washers. For the five exemplar machines tested in this investigation, measurements of the length of the air tube, diameter of the air dome's nipple, and length of the air dome's nipple were made as presented in Table 1.

Table 1 – Variations in Relevant Sizes of Air Tube and Air Dome Nipple

Machine Model #	Air Dome Nipple Dia (in.)	Air Dome Nipple Length (in.)	Air Tube Overall Length (in.)
FEX83IFS	0.230	0.560	50.91
FGX83IFS	0.225	0.555	52.31
FFLG2022MW	0.225	0.571	15.89
FFLE2022MW	0.225	0.570	15.85
FAHE4044MW	0.224	0.567	15.77

The length of the air tube is an important parameter affecting the connection integrity of the air tube with either the air dome and pressure switch / transducer. Ideally, it should not be too short to pull at the connection point, but it should also not be too long to avoid extra loose mass of tubing from generating undesirable forces at the connection point during normal acceleration cycles of the tub. According to Newton's 2nd law of motion (F= ma), where "F", "m" and "a" represent Force, Mass and Acceleration, respectively, the larger the mass of an accelerating object, the greater the forces it generates. As such, any extra length of the air tube, in the form of a strain-relief service loop as suggested by the plaintiff, only exacerbates the undesirable forces at the connection point of the air tube. During normal operation of the washing machine, rotational acceleration of the tub causes the service loop to move from side to side, slapping against the tub and pulling against the adhesive tape, which could potentially result in excessive undesirable forces at the connection point of the air tube with the air dome and pressure switch / transducer. Machines with varying air tube lengths, therefore, would need to be examined separately to determine whether the particular length of air tube utilized in those machines is too long or too short. Machines with longer air tubes will have to be examined separately from machines with shorter air tubes to determine whether, among other things, the longer tube creates excessive external force due to its larger mass.

2. Plastic vs. Metallic Pressure Switch Housing Material

Some Electrolux machines currently in use employ pressure switches with plastic housing, while others employ a metallic housing. The change from metal to plastic housing for the pressure switch apparently occurred as a result of change in vendor supplier for this switch. A previous vendor had utilized a metal housing, and therefore a metal nipple in construction of the pressure switch. As such, there would be differences in friction characteristics between the air tube material and pressure switch nipple that could affect the interference fit and nature of connection between the air tube and the pressure switch, depending on whether the pressure switch nipple is made of metal or plastic. Because various models may employ either metallic or plastic nipples, there are obvious variations in friction characteristics that are relevant to plaintiff's allegation of a common design defect.

3. <u>Pressure Switch vs. Transducer Design</u>

In some Electrolux manufactured machines the air tube is connected to a pressure switch, while in other Electrolux machines the air tube is not even connected to a pressure switch, but rather to an electronic transducer. Since pressure switches are spring-controlled mechanical devices, they are more prone to usage related wear and tear resulting in inaccuracies in sensing the pressure and hence the water level in the tub. This is not a problem that is associated with piezoelectric based transducers used in some Electrolux washers. Since the weight of the water contained in the tub directly affects the vibrational forces governing the likelihood of tube separation from the air dome, (i.e., the more water in the tub, the greater the mass that is moving around when the tub spins, and the greater the resulting vibrations generated by that movement), variations in water level between machines employing a pressure switch and machines employing a transducer is relevant to plaintiff's allegation of a common design defect.

4. <u>Revisions to Air Dome Design</u>

While there are 6 different revisions for the air dome, the most notable revision is the addition of a mold draft to the nipple in revision "F" as depicted in Electrolux CAD diagram 145055 (ELUX 01003, 01004). This appears to have been a design change to aid in the injection molding production of the part. The existence of these designs variations, and their effect on the connection characteristics of the air tube to the air dome and pressure switch / transducer is not addressed by the plaintiff.

5. <u>Design of Vibration Absorption Spring System</u>

Within a reasonable degree of engineering certainty, the most significant component of the external operating force influencing the probability of air tube separation from either the air dome or the pressure switch / transducer, is the net vibrational energy delivered to the air dome / air tube interface from the motor assembly via the tub. The term "net" vibrational energy refers to the gross vibrational energy created by the motor, less the amount of vibrational energy absorbed by the spring system configured at 120-degree intervals around the bottom of the tub.

Inspection of the five exemplar Electrolux machines revealed the existence of 3 different designs of the vibration absorption system. The observed design variations included variations in the number of springs utilized in the machine (6 total springs for machine numbers 1, 2, and 9 springs for machine numbers 3-5), variations in the size of employed springs, variations in the as-installed orientation of the springs, as well as the stiffness of the springs. Figure 4 shows the 3 variations of the vibration absorption system observed on the exemplar machines. Each unit is comprised of a set of 2 springs (one large spring and one small spring) or set of 3 springs (two small springs and one large spring). Figure 5 shows the relative size comparison amongst the springs. Amongst the five exemplar machines tested, the documented variations in the design and characteristics of the vibration dampening spring system will have a relevant effect on the "net" vibrational energy delivered to the components of the machine, and therefore on the probability of failure as alleged by the plaintiff.

6. <u>Tri-axial (XYZ) Vibration Profile Measured at the Tub</u>

Measurements of the actual vibration profiles were made by mounting a tri-axial accelerometer on the tub surface near the air dome with X, Y, Z, measuring the horizontal in-plane, vertical in-plane, and horizontal out-of-plane accelerations experienced during the rinse and spin cycle of each machine, as shown in Figure 5. As evidenced by the collected acceleration data (units of g), and as expected, the peak magnitude and vibration signatures are unique to the design of each type of machine tested. This is expected as the design of components generating the motion of the tub, as well as the vibration absorption mechanism is distinctly different from one machine to another, thereby resulting in different "net" vibrational energy in each machine type as shown in Figure 6. Therefore, any variations in the design of motion producing components of Electrolux washing machines, as well as variations in the design of the vibration absorption components, will be relevant in assessing the validity of plaintiff's allegation regarding a common design defect.

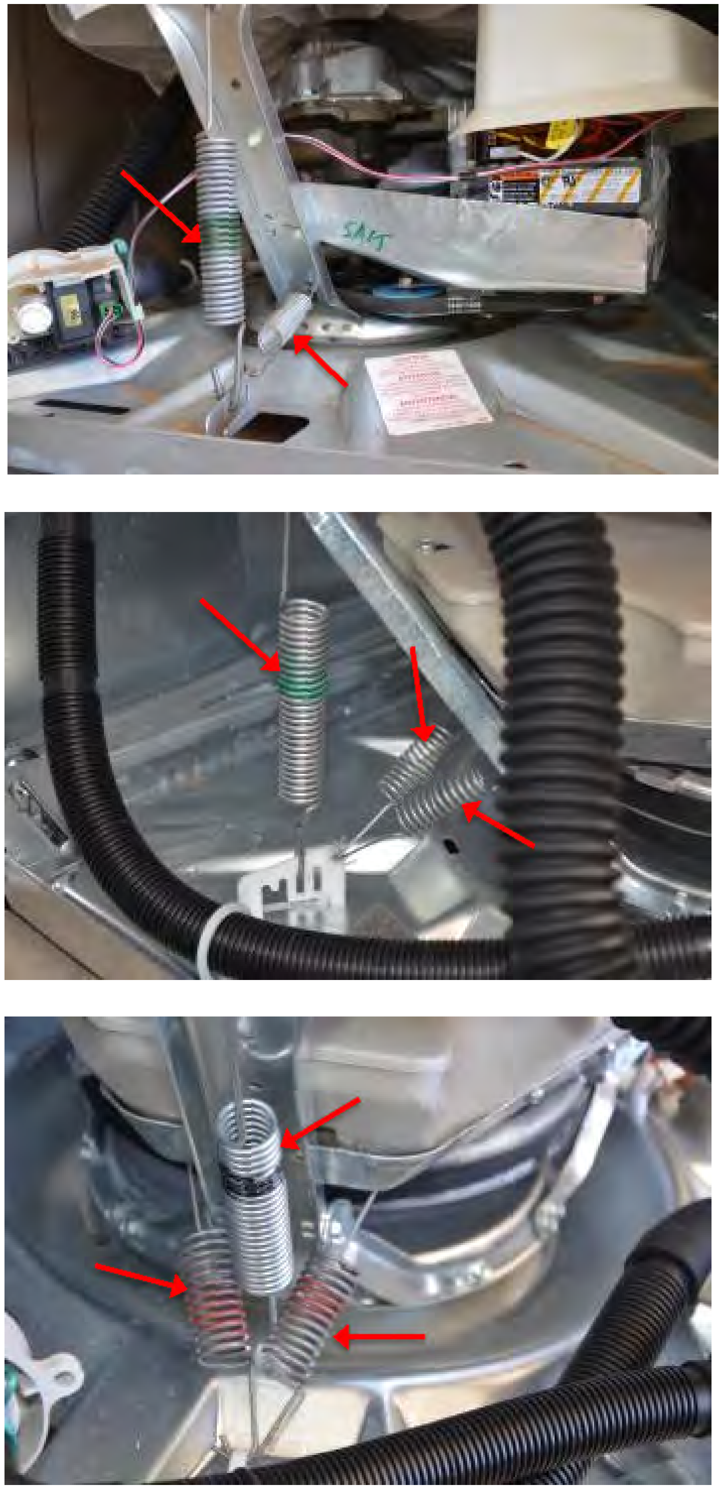
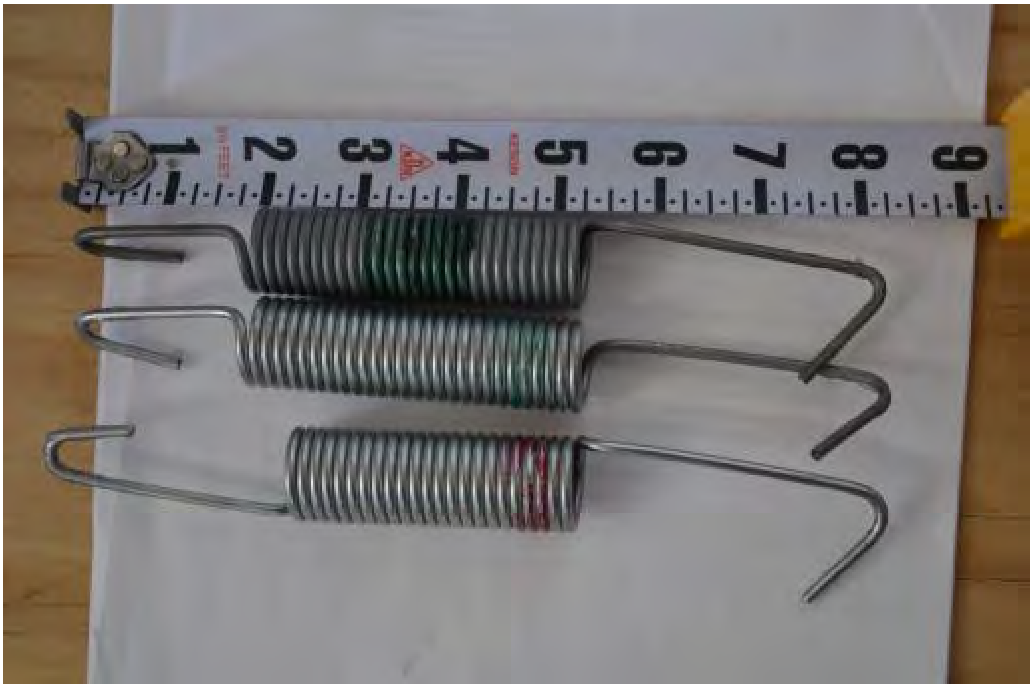


Figure 4 – Variations in the Design of the Vibration Absorption Spring System. Top (FEX83IFS, FGX83IFS), Middle (FFLG2022MW, FFLE2022MW) and Bottom (FAHE4044MW)



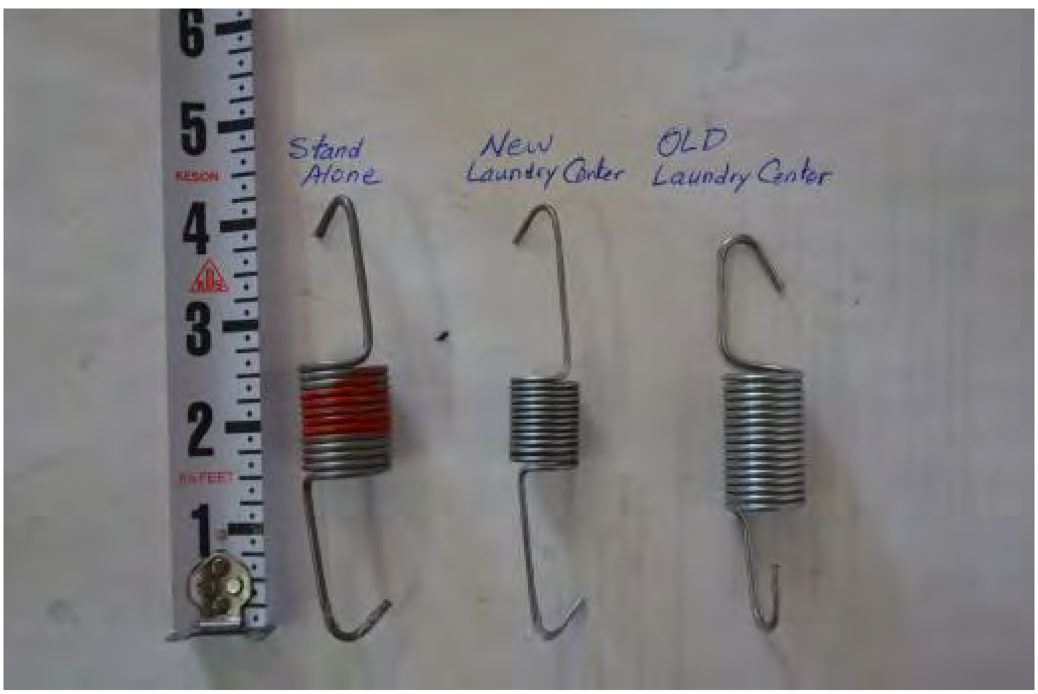


Figure 5 – Comparison of Large and Small Springs Employed in the 5 Exemplar machines (3 types) tested – Large Springs (top), and Small Springs (bottom).

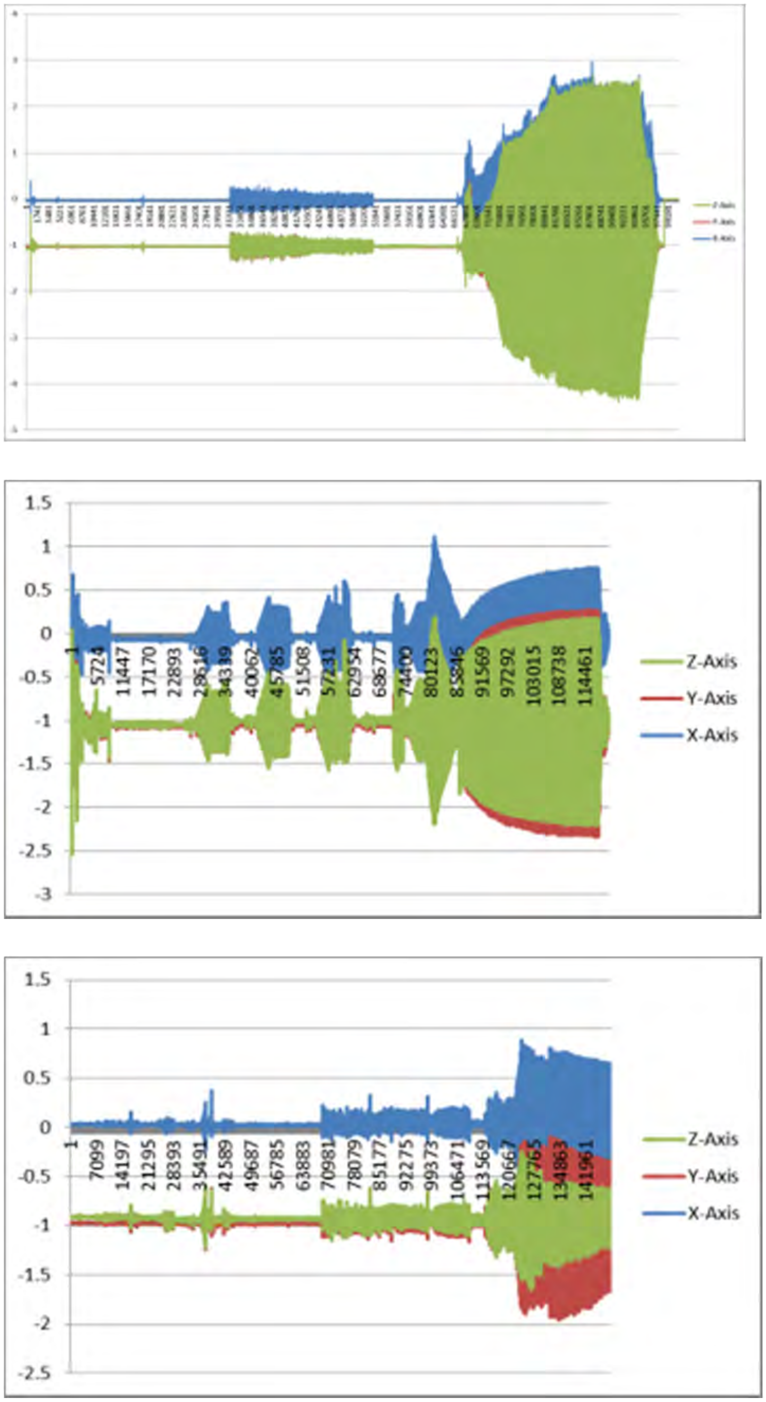


Figure 6 – Tri-axial (XYZ) vibration profile of the exemplar machines tested.
Top Profile: Models FEX83IFS and FGX83IFS
Middle Profile: Models FFLG2022MW, FFLE2022MW
Bottom Profile: Model FAHE4044MW

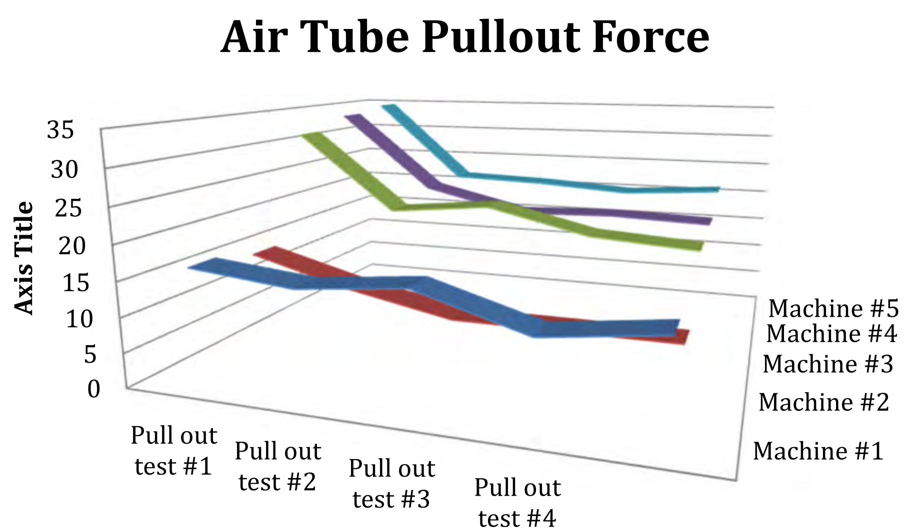
7. **<u>Manufacturing Variations in Interference Fit</u>:**

The internal forces contributing to preservation of the connection between the ends of the air tube with either the air dome or the pressure switch / transducer are created through "interference fit", which is a technical term referring to a method of connecting two pieces through geometrical interference. In this case, the internal diameter of the air tube is somewhat smaller than the outer diameter of the connecting nipples of the air dome / pressure switch, resulting in interference forces that resist separation of the air tube from the air dome and/or the pressure switch. Due to dependence of the magnitude of the interference force (a direct measure of the strength of the connection) on relative geometries of the connecting components, the magnitude and integrity of the internal connecting force is influenced by geometrical variations among the inner diameters of various air tubes used in different groups of Electrolux washing machine. Table 2 depicts the variations observed within the five exemplar washing machines examined (FEX83IFS, FGX83IFS, FFLG2022MW, FFLE2022MW and FAHE4044MW).

Table 2 – Variations in Air Tube's O.D. and I.D. Amongst Tested Machines

Model #	Air Tube O.D. (in.)	Air Tube I.D. (in.)
FEX83IFS	0.375"	0.184"
FGX83IFS	0.375"	0.184"
FFLG2022MW	0.347"	0.176"
FFLE2022MW	0.347"	0.176"
FAHE4044MW	0.347"	0.176"

The above measurements indicate that the air tube dimensions are different from model to model and the inner diameter has shrunk by an average of 0.008". The outside dimensions are also different from model to model, by as much as of 0.028", which is quite significant. This observed variability in the air tube's inner diameter from one model to another would have a direct effect on the magnitude of the interference force (gripping strength) and resultant internal force of connection between the air hose and the air dome / pressure switch. In fact, this variability was measured by conducting direct pull tests on the air tube of each of the 5 exemplar washing machines tested in this study. Using a calibrated force transducer connected to a loop above the connection point of the air tube to the air dome, an increasing vertical force was applied to the air tube measure the pull out force necessary to disengage the air tube from its connection point to the air dome. For each machine, following the initial air tube pull out, the air tube was reconnected to the air dome and the same pull-out tests were repeated for a total 5 tests for each machine. As shown in the results presented in Figure 7, the effect of inner diameter variations on the pull out force of the air tube is as high as 130%. Specifically, exemplar washing machines 1 and 2 having an I.D. of 0.184 in. required an average force of approximately 15.8 lbs to separate the hose from the air dome, while washing machines 3, 4, and 5 having smaller air tube I.D.'s of 0.176 in., required an average force of 33.2 lbs (an increase of 110%) before the air tube would disconnect from its connection point to the air dome. Note that tests conducted after the initial pull out test resulted in lower values of the pullout force due to the fact that the initial assembly bond created by the use of Ai-30 solution during assembly of the air tube was broken after the first run. This means that washing machines whose air tubes have been disconnected for any reason (e.g., for repairs, testing, etc.) will need to be examined separately from machines whose air tubes have never been disconnected following the original assembly process. While the air hose separation criterion described in section VI may be satisfied in one group of Electrolux manufactured washing machines, variations in air tube diameter are significant enough to potentially not result in air tube separation in another group of washing machines.



	Pull out test #1	Pull out test #2	Pull out test #3	Pull out test #4	
Machine #1	16.5	15	16.5	12	14
Machine #2	15	11	8	8	8
Machine #3	31.5	20	21.5	18	17
Machine #4	33.5	21.5	18	18.5	18
Machine #5	34.5	21.5	21	20	21

Figure 7 – Air Tube Pull-Out Force (lbs) for Five Exemplar Machines Tested

Where:

Machine #1: Model # FEX83IFS
Machine #2: Model # FGX83IFS
Machine #3: Model # FFLG2022MW
Machine #4: Model # FFLE2022MW
Machine #5: Model # FAHE4044MW

* All force measurements are in units of lbf.

8. **Application of Ai-30 During Air Tube Assembly:**

Ai-30 is a solution of blended solvent degreaser containing petroleum distillate. Each end of the air tube is dipped into the Ai-30 solution prior to inserting it into the nipple of the air dome/pressure switch. Within a short period of time Ai-30 cures, forming a thin layer of bond between the inner surface of the air tube and the exterior surface of the air dome/pressure switch nipple. This bond provides additional forces for preserving the connection between the air tube and the air dome/pressure switch. The variations in the strength of this bond, and therefore variations in the magnitude and integrity of the resultant internal connecting force is influenced by the manner in which the assembly personnel apply the Ai-30 solution, or whether Ai-30 solution is applied at all to the air tube prior to inserting it onto the air dome / pressure switch nipples. This variability in bond strength will have a direct effect on the magnitude of the externally applied force required to cause separation of the air tube from the air dome / pressure switch. Therefore, while the air hose separation criterion described in section VI may be satisfied in one group of Electrolux manufactured washing machines, variations in the bond strength between the air tube and air dome / pressure switch can be significant enough to potentially not result in air tube separation in another group of washing machines.

This effect was tested in all five exemplar machines via measurement of the force necessary to separate the air tube from its connection point to the air dome. Following the initial test and measurement of the pullout force, the air tube was reconnected to the air dome and the pull out force was re-measured. Since the bond created by the application of the Ai-30 during assembly of the air tube was broken after the first pullout test on each machine, subsequent runs 2-5 on each machine resulted in significantly lower values of the pull out force as indicated in Tables 3-7.

Table 3 – Air Tube Pullout Test Results for Machine #1 (Model # FEX83IFS)

Run #	Pullout Force (lbf)
1	16.5
2	15
3	16.5
4	12
5	14

Table 4 – Air Tube Pullout Test Results for Machine #2 (Model # FGX83IFS)

Run #	Pullout Force (lbf)
1	15
2	11
3	8
4	8
5	8

Table 5 – Air Tube Pullout Test Results for Machine #3 (Model # FFLG2022MW)

Run #	Pullout Force (lbf)
1	31.5
2	20
3	21.5
4	18
5	17

Table 6 – Air Tube Pullout Test Results for Machine #4 (Model # FFLE2022MW)

Run #	Pullout Force (lbf)
1	33.5
2	21.5
3	18
4	18.5
5	18

Table 7 – Air Tube Pullout Test Results for Machine #5 (Model # FAHE4044MW)

Run #	Pullout Force (lbf)
1	34.5
2	21.5
3	21
4	20
5	21

9. Frictional Forces at the Contact Surface Between the Air Tube and the Air Dome / Pressure Switch

In addition to the interference fit and Ai-30 assembly application components of the internal resultant connection force, another factor contributing to the internal resultant connection force at the air tube / nipple interface is the frictional force between the sliding surfaces of the air tube and nipple material. This is the third component of the overall resultant internal force that contributes to the overall internal force that helps to resist sliding of the air tube with respect to the air dome / pressure switch nipple.

Force of friction, F, between any two sliding surfaces is governed by two factors, namely, 1) the force of contact (N) perpendicular to the direction of sliding motion (in this case the force created by the interference fit between the air tube and the air dome nipple), and 2) the coefficient of friction (μ), which is a function of the type of materials that are sliding with respect to each other. For example, the coefficient of friction between a polystyrene material and a steel material is ~0.3, while the coefficient of friction between a polystyrene piece sliding against another polystyrene piece is ~0.5 (67% higher). The force of friction resisting the sliding of one material against another can be determined via the equation $F = \mu N$.

As discussed earlier, there is an inherent variability in the magnitude of the interference fit contact force (N) between the air tube and the air dome / pressure switch's nipple due to variations in the size of air tube's inside diameter. In addition, the coefficient of friction for sliding of air tube against the air dome's nipple would also be different depending on whether the air dome is made of a plastic or metallic material. Therefore, variations in the contact force (N) between the air tube and the air dome/pressure switch, as well as variations in the coefficient of friction (μ), can result in significant variations in the friction force that resists the external forces acting to pull out the air tube. While the air hose separation criterion described in section VI may be satisfied in one group of Electrolux manufactured washing machines, variations in the frictional forces between the air tube and the air dome / pressure switch can be significant enough to potentially not result in air tube separation in another group of washing machines.

10. <u>Placement of Strain-relief Tape</u>

The precise placement of each tape can be found on Electrolux CAD diagram 1315956, "Assembly Hose Routing". The diagram illustrates and describes in detail the placement of the tape, centered and just above the date stamp that is placed on each water tub. This placement puts the tape strain-relief mechanism directly in line with the air dome and the plastic molded retainer clasp located on the splash tub cover. Electrolux document #1319812, "TAPE-LOW TACK", provides the required specification for the tap. Multiple part numbers and approved vendors are listed on the document. The tape is employed as a stress-relief mechanism against adverse effect of "Tube Slap".

Placement of the strain-relief tape at its designated location plays an important role in maintaining the orientation of the air tube in line with the orientation of the nipple on the air dome, as well as insuring that the inertia forces produced during rotational movement of the tub are not transferred to the connection point of the air tube with the air dome. If the tape is placed too low or too high, or not at all (due to inherent variations in a manual assembly process), the weight of the unsupported length of the air tube will result in generation of inertia forces that could result in excessive external forces at the air tube connection point (Figures 8 and 9). The solution offered by the plaintiff, in the form of a service loop, would actually result in detrimental inertia forces at the connection point of the tape to the tub, which could result in the tape to become loose or to separate, leaving the connection point of the air tube to the air dome vulnerable to separation.

The existing strain-relief mechanism employed by Electrolux utilizes a fiber-reinforced adhesive tape that secures the air tube to the outside of the tub at about 10-12 inches above the connection to the air dome. This is an effective and proven method of relieving the operating stresses at the air tube connection point. Isolated instances may exist where insufficient tape length, imprecise placement of the tape, or failure of the tape due to surrounding environmental conditions may affect the effectiveness of the tape as a stress-relief mechanism. The potential for inherent variability in placement of the tape could affect the effectiveness of the tape as a strain-relief mechanism, and as such, it would be a relevant factor in assessing the validity of plaintiff's allegation regarding a common design defect.

11. Effect of Burner Proximity to Pressure Switch on Thermal Cycling of Air Tube

I have examined both gas and electric models of Electrolux washing machines, more specifically, machine model numbers FFLG2022MW/FFLE2022MW and FGX83IFS/FEX83IFS. Each type of machine had a distinct difference with respect to the Air tube's connection to the Air Pressure Switch. In the gas models I examined, the dryer's burner proximity to the air pressure switch may cause thermal cycling and thermal expansion of the Air Tube, which in return could affect the connection characteristic of the Air Tube to the Air Pressure Switch. As a consequence, in the gas model, two additional clamps are utilized in order to prevent the unwanted separation of the pressure tube from the pressure switch. This additional clamping necessarily impacts whether the air tube in a particular washing machine is more or less likely to disconnect from the pressure switch, as it necessarily impacts the manner in which the air tube moves and vibrates; the clamping, or lack thereof in some machines, is another variable that can enhance or dampen the external force pulling the air tube away from the pressure switch / transducer.

Figure 8 – Variations in placement of the strain relief tap in exemplar washing machines model # FAHE4044MW (Top), and model # FFLG2022MW (Bottom)

Figure 9 – Variations in placement of the strain relief tap in exemplar washing machines model # FFLE2022MW (Top), and model # FEX831S (Bottom)

12. Effect of Maximum Spin Speeds

Rotational speed of the drum during normal operating conditions translates into inertia forces that exert a radially outward force on connecting components. A direct evidence of this force is that following a spin cycles, clothes are normally found compressed and stuck to the interior periphery of the tub due to this inertia force caused by spinning of the tub. This radially outward inertia force, F, can be calculated by the equation below:

$$F = m\, r\, \omega^2$$

Where, "m" is the mass of the rotating object, "r" is the distance of the object from the center of rotation, and "ω" is the angular rotational speed, more commonly referred to as the "spin speed". It is important to note that the resulting inertia force of the rotation exerted on a spinning object, F, is a square function of the spin speed, i.e., doubling the spin speed results in quadrupling the inertia force.

To make the above point in reference to the exemplar washing machines tested in this investigation, the gas or electric washer/dryer laundry centers (FFLG2022MW / FFLE2022MW) run at a maximum spin speed of 600 rpm*, while the High Efficiency Top Load Washer (FAHE4044MW) runs at a maximum speed of 800 rpm**, as noted in Table 8. While the increase in maximum spin speed from 600 to 800 rpm represents a 1.33 times (133%) increase in spin speed, the increase in the resulting inertia force pulling the air tube in a radially outward direction is 1.33^2 or 1.78 times (178%).

As demonstrated above, variations in the spin speed among different machines result in significant variations in the magnitude of external forces and whether the tube separation criterion would be met for machines operating at different spin speeds. This factor must be considered in determining whether a common design defect exists or not.

Table 8 –Maximum Spin Speed Variation Between Different Models

Machine Model	Maximum Spin Speed (RPM)
FFLG2022MW / FFLE2022MW	600*
FAHE4044MW	800*

* http://www.frigidaire.com/Washers-Dryers/Laundry-Center/Laundry-Centers/FFLG2022MW/
* http://www.frigidaire.com/Washers-Dryers/Laundry-Center/Laundry-Centers/FFLE2022MW/
** http://www.frigidaire.com/Washers-Dryers/Washers/Top-Load/FAHE4044MW/

13. Combo vs. stand-alone top-load washers

One major difference between stand-alone top load machines and combo washer/dryer laundry centers is their weight. For example, the gas or electric washer/dryer laundry centers (FFLG2022MW / FFLE2022MW) weigh 250 lbs*, while the High Efficiency Top Load Washer (FAHE4044MW) weighs 171 lbs**., as noted in Table 9 The relevance of this significant weight difference (laundry center is 146% heavier than the stand-alone top load) is that heavier machines are physically more stable and inherently harder to move around than their lighter top-load counterparts due operating forces during the spin cycle. This physical difference in the weight of different machines, in turn translates into different vibration-induced forces experienced by the air tube at its connection point to the air dome and/or pressure switch / transducer. Therefore variations in weight of different washing machines is a relevant factor that must be considered in considering the probability of failure and whether the air tube separation criterion will be satisfied in washing machines of different weight.

Table 9 –Weight Variation Between Different Models

Machine Model	Weight (lbs)
FFLG2022MW / FFLE2022MW	250*
FAHE4044MW	171*

* http://www.frigidaire.com/Washers-Dryers/Laundry-Center/Laundry-Centers/FFLG2022MW/
* http://www.frigidaire.com/Washers-Dryers/Laundry-Center/Laundry-Centers/FFLE2022MW/
** http://www.frigidaire.com/Washers-Dryers/Washers/Top-Load/FAHE4044MW/

14. **Professional vs. Non-professional setup & installation**

As discussed earlier, variations in vibration induced forces play an important role in whether the criterion of air tube separation (A>B) is satisfied. In addition, vibration of spinning components, in turn, is sensitive to whether the machine is operating in a balanced condition, and whether it is operating on a stable and level surface. Relative to machines installed by non-professional consumers, it is more likely that machines installed and serviced by professional installers, are less prone to operating vibrations resulting from improper setup, imbalance and/or lack of levelness. Therefore, in considering whether the air tube is more or less prone to disengage from the air tube and/or the pressure switch of a given machine, the effect of professional vs. unprofessional installation must be taken into account.

15. **Service related damage**

In order to perform any maintenance and/or repair services, it is necessary to remove the front panel or the control panel in order to gain access to the inside of the machine. As discussed earlier in section 7, the force necessary to pull the air tube out of the connecting nipple of the air dome significantly decreases after the air tube has been pulled out once and reinserted again (Figure 7), due to the breakage of the initial bond created by the application of Ai-30 during the assembly process. This weakening of the air tube connection to the air dome / pressure switch could also occur if a person repairing a given machine, inadvertently pulls on the air tube, resulting in breakage of the Ai-30 bond layer. Therefore, whether a given machine has been repaired in the past or not is a relevant consideration in deciding whether a group of machines are more or less likely to suffer from air tube separation.

16. Effect of Cycle and Total Run Time

The long-term effect of the resultant external force of separation (A) on the likelihood of air tube separation is directly proportional to the number of cycles that each of the machine. For example, two machines running at the same spin speed, but for different lengths of spin cycle time, will be subjected to larger or smaller number of cycles of that variable, in machines having longer or shorter spin cycle time, respectively. This is akin to the effect of sun exposure on skin. For a given level of UV radiation, the longer one lays out in the sun, the more likely he/she is to observe the adverse effects of sun exposure. To this end, the exemplar machines employed in this study were run through their entire range of cycles and the length of each operating cycle was precisely measured and recorded, as presented in Table 10.

Table 10 – Time Duration (min.) of Wash, Drain, Rinse, Spin Cycles, and Total Run Time

MACHINE	*Wash Cycle*	*Drain Cycle*	*Rinse Cycle*	*Spin Cycle*	*Total Run Time*
FGX831FS (2)	18.31	1.94	13.17	9.68	43.1
FFLG2022 (3)	28.20	6.90	10.30	10.11	55.51
FAHE4044MW (5)	35.51	6.77	8.50	16.63	67.41

As noted in Table 10, different cycle time durations exist amongst different machines. Therefore, the overall effect of external forces of separation (A) would be highly dependent on the duration of machine's different operating cycle times (Table 10), and should be considered in determining the likelihood of failure in different machines.

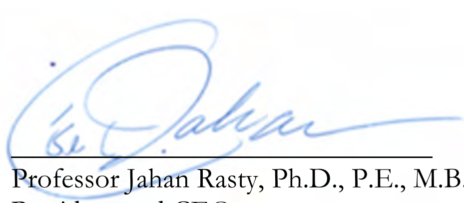
VIII. Conclusions

As demonstrated, I conclude to a reasonable degree of engineering certainty that variations among the Electrolux washing machines that plaintiff seeks to include within his proposed class. These variations directly impact the likelihood that any particular washing machine might overflow and demonstrate that there is no common defect.

IX. DISCLAIMER

The opinions stated in this report are based on the review of case documents available to date and inspection and tests conducted on 5 exemplar Electrolux washing machines as listed in the body of this report. I reserve the right to expand upon or to revise the aforementioned opinions and conclusions as more information is made available to me through discovery, research, and/or testing.

Submitted By:



Professor Jahan Rasty, Ph.D., P.E., M.B.A
President and CEO

--END OF REPORT--

Appendix A

CV

Jahan Rasty, Ph.D., PE, MBA

JAHAN RASTY, PH.D., PE, MBA

HOME ADDRESS:

9506 York Ave.
Lubbock, Texas 79424

BUSINESS ADDRESS

Professor
Department of Mechanical Engineering
Texas Tech University
Lubbock, Texas 79409-1021
Tel (806) 834-6571

CITIZENSHIP: U.S.A.

SPECIALIZATION: **Experimental and Numerical Solid Mechanics** with Emphasis:

- Materials, Mechanical Design/Mechanisms, Injury Biomechanics
- Forensic Engineering, Root-Cause Failure Analysis, Manufacturing
- Fatigue & Fracture, Corrosion, Stress Analysis, Metallurgy
- Destructive and Nondestructive Residual Stress Measurement
- Dynamic Events: Impact, Explosives, Metal Forming, Thermal Stress
- Slips, Trips and Falls, Tribology (Analysis of Surface Friction)

EDUCATION:

MBA, 1999: College of Business Administration, Texas Tech University.

Ph.D., 1987: Department of Mechanical Engineering, **L**ouisiana **S**tate **U**niversity (**LSU**).
Dissertation Title: "*Experimental and Finite Element Study of Residual Stresses Induced by Non-homogeneous, Large Deformation Manufacturing Processes: Application to Zircaloy-4(R) Nuclear Fuel Cladding and Oxygen-Free High Conductivity (OFHC) Copper Tubes.*"

B.S./M.S. 1981/1984: Department of Mechanical Engineering, **L**ouisiana **S**tate **U**niversity (**LSU**).
Thesis Title: "*The Effect of Imperfect Contact Between Adjacent Layers on the Integrity of Multilayer Wrapped Pressure Vessels with Interlayer Gaps.*"

LICENSE: Registered Professional Engineer, State of Texas, Certificate No. 71689.

PROFESSIONAL CIRTIFICATIONS:

2007: Successfully completed the Vetronix/Bosch approved standardized 8-hour ***Crash Data Retrieval (CDR) Technician Certification*** Course, September 9, 2007, North Las Vegas, NV.

2007: Successfully completed the Vetronix/Bosch approved 32-hour Crash Data Retrieval (CDR) Data Analyst Course to qualify for individual ***CDR System Operator Certification***, September 10-13, 2007, North Las Vegas, NV.

PROFESSIONAL AFFILIATIONS:

- American Society of Mechanical Engineers (ASME International) – Member
- National Society of Professional Engineers (NSPE) - Member
- National Academy of Forensic Engineers (NAFE) – Senior Member
- National Association of Corrosion Engineering (NACE International) - Member
- Council of Engineering Specialty Boards (CESB) – Board Certified Diplomat
- National Association of Fire Investigators (NAFI) - Member
- Society for Experimental Mechanics (SEM) - Member
- American Society of Materials (ASM International) – Member
- Society of Automotive Engineers (SAE International) – Member
- Electronic Device Failure Analysis Society (EDFAS) – Member

ACADEMIC ACHIEVEMENTS AND AWARDS:

2010: Nominated as "Exceptional Professor" at the 2010 Texas Tech University Honors Convocation

2009: Pi Tau Sigma Honorary Mechanical Engineering Society – "Most Influential Professor" award.

2007: Pi Tau Sigma Honorary Mechanical Engineering Society – Best Professor Award for the course: "*Principles of Failure Analysis & Forensic Engineering*"

2002-05 The American Society of Mechanical Engineers (ASME) International, Board of Governors – Regional Secretary

2002: The American Society of Mechanical Engineers (ASME International), Board of Governors – in recognition for "valued service in advancing the engineering profession as Assistant Vice President for Education (1999-2001) and Vice Chair for Education (1998-1999)."

2002: Texas Tech American Society of Mechanical Engineers (ASME) Student Chapter Service Award – in recognition of 13 years of service as the Faculty Advisor for the ASME chapter.

2001: The American Society of Mechanical Engineers (ASME) International Meritorious Service Award – in recognition for his efforts in coordinating the Graduate Student Technical Conference (GSTC).

1993: Halliburton Education Foundation Award of Excellence for Outstanding Achievement and Professionalism in Education, Research and Service,

1992: The American Society of Mechanical Engineers (ASME) International Counsel on Member Affairs Award for outstanding contributions as the Faculty Advisor to the ASME Student Section at Texas Tech,

1992: Ralph Teetor award for education/research, Society of Automotive Engineers,

1991: The American Society of Mechanical Engineers (ASME) International Board of Governors award for valued services in advancing the engineering profession.

1990: Halliburton Education Foundation Award of Excellence for Outstanding Achievement and Professionalism in Education, Research and Service,

1989: Alcoa Foundation Grant Award for Excellence in Research,

1986: American Public Works Association (APWA) Grant Award,

1984-87: Kaiser Aluminum and Chemical Company Fellow in Materials Science,

WORK EXPERIENCE:

1/95-present: Real-World Forensic Engineering, LLC – Lubbock, TX
President & CEO
Served as engineering consultant to industry and government labs, as well as service as a forensic engineer to insurance companies and attorneys. Conducted 100's of failure and accident investigations for determining the root-cause of failures. Gained valuable forensic engineering experience in multitude of cases including, but not limited to, heavy machinery, medical devices, fire cause and origin, slip and fall, boilers and pressure vessels, explosive devices, fasteners, oil and gas components, etc.

1/85-7/85: ETHYL Corp., Baton Rouge, Louisiana.
Project Engineer
Evaluated the stresses and displacements of reactor vessels under operating conditions and recommended modifications in the design of the vessels. Analysis was conducted using the existing theoretical solutions. In addition, ANSYS Finite Element Program was utilized to verify the theoretical results. Due to complex geometry of reactor parts being analyzed, extensive experience in modeling of mechanical parts with complex geometry and boundary conditions was obtained.

ENGINEERING TEACHING EXPERIENCE:

2008-present: **Full Professor,** Department of Mechanical Engineering, Texas Tech.

1993-2008: **Associate Professor,** Department of Mechanical Engineering, Texas Tech.

1988-1993: **Assistant Professor,** Department of Mechanical Engineering, Texas Tech,

Taught and Developed **(**)** the Following Undergraduate and Graduate Courses:

1) Mechanics of Solids (ME 3403)
2) Failure Analysis & Forensic Engineering **(**)**, TTU-ME 4342
3) Mechanical Metallurgy **(**)**, TTU-ME 4343,
4) Materials Science, TTU-ME 2311,
5) Statics, TTU-ME 3464
6) Measurements & Instrumentation Laboratory – ME 3218
7) Materials and Mechanics Laboratory, TTU-ME 3328
8) Materials in Design **(**)**, TTU-ME 4341,
9) Manufacturing Processes **(**)**, TTU-ME 4344,
10) Dynamics, TTU-ME 3331,
11) Introduction to Machine Design, TTU-ME 3364,
12) Machine Component Design, TTU-ME 3365,
13) Mechanical Systems Laboratory, TTU-ME 4252,
14) Applied Mechanics **(**)**, TTU-ME 4362,
15) Senior Design-I, TTU-ME 4370,
16) Senior Design-II, TTU-ME 4371,
17) Individual Studies, TTU-ME 4331,
18) Fracture and Failure Analysis **(**)**, TTU-ME 5342 (graduate)
19) Foundations of Solid Mechanics **(**)**, TTU-ME 5352 (graduate),
20) Plasticity and Viscoelasticity **(**)**, TTU-ME 5353, (graduate),
21) Theory of Thermal Stresses **(**)**, TTU-ME 5344, (graduate),
22) Deformation Mechanics **(**)**, TTU-ME 5331, (graduate).
23) Dislocation Mechanics **(**)**, TTU-ME 5343, (graduate).
24) Corrosion and Degradation of Materials in Nuclear Industry (**), TTU-ME 6330 (graduate)
25) Legal Principles in Forensic Science and Engineering (**), TTU-ME 6330 (graduate)

PROFESSIONAL DEVELOPMENT

2009: Attended a full day workshop and hand-on training course for ***"Safe Operation of Forklifts",*** presented by office of Environmental Health and Safety, Texas Tech University, May 2009, Lubbock, TX,

2008: Attended a 1½ day workshop on "***Intellectual Property in the 21st Century***", presented by Dr. Raymond Van Dyke, Esq., Patent Attorney Partner, Winston & Strawn, LLP, in Washington D.C., April 11-12, 2008, Texas Tech University

2007: Attended the a workshop sponsored by ABAQUS corporation on "***Computer Aided Modeling and Application of Finite Element Method to Fracture and Failure Analysis***.", May 11-12, Dallas, TX

2006: Attended a workshop sponsored by ABAQUS corporation on "***Computer Aided Modeling and Application of Finite Element Method to Fracture and Failure Analysis***.", May 11-12, Dallas, TX

2002: Attended the American Society of Mechanical Engineers (ASME International) Management Training Seminar, August 10, 2002, San Antonio, TX

1997: Successfully completed a course on ***"Interpersonal Skills"*** at the ASME Region X Management Training Seminar held on April 4-5, 1997 in Arlington, Texas

1997: Successfully completed a course on ***"Mutil-Scale Modeling of Polycrystal Plasticity"*** at the Institute for Mechanics and Materials Seminar held on April 9-11, 1997 in San Diego, California.

1993: Successfully completed a course on "***Teaching Effectiveness***" presented at the National Effective Teaching Institute's workshop held at the University of Illinois at Urbana-Champaigne, June 24-26, 1993

1990: Successfully completed a course on "***Probabilistic Structural Analysis Methods and NESSUS Workshop***" presented by the Southwest Research Institute, San Antonio, Texas, April 16-20, 1990

1989: Successfully completed a course on ***"Integrated Learning System - Improving Engineering Education,"*** Presented by Dr. K.J. Williamson, and P.K. Hurt, in a teaching effectiveness workshop held at Texas Tech University

1988: Successfully completed a course on "***Creating Creative Engineers***", presented at the National Effective Teaching Institute's workshop held at North Carolina State University, June 11-13, 1988

1984: Successfully completed a course on "***Teaching Effectiveness***" presented by Professor James E. Stice, at the Center for Teaching Effectiveness Workshop, held at Louisiana State University, March15-17, 1984

PROFESSIONAL CIRTIFICATIONS:

2007: Successfully completed the Vetronix/Bosch approved standardized 8-hour ***Crash Data Retrieval (CDR) Technician Certification*** Course, September 9, 2007, North Las Vegas, NV.

2007: Successfully completed the Vetronix/Bosch approved 32-hour Crash Data Retrieval (CDR) Data Analyst Course to qualify for individual ***CDR System Operator Certification***, September 10-13, 2007, North Las Vegas, NV.

RESEARCH & PROJECT MANAGEMENT EXPERIENCE:

1988-Present: Department of Mechanical Engineering , Texas Tech University, Lubbock, TX.

Funded Research:

Served as the PI and/or Co-PI of 27 research projects (listed below) with a total funding of $7,515,759. (other non-funded research projects are not listed.)

1) Principal Investigator (100%), "Failure Analysis & Performance Characterization of Wind Tower Bolts", $5,600

2) Co-Investigator, "Study and Improvements to the Hall Pump", Funded by T&B Financial Services, $11,939

3) Principal Investigator, "Corrosion and Radiation Effects on Electronic Materials", Funded by Nuclear Regulatory Commission / UK, $25,000

4) Principal-Investigator: "Experimental and Finite Element Characterization of Residual Stresses", Funded by AFOSR/Lockheed Martin/Boeing PCC 02 KY4111 F/A-22 Program, $5,000, 8/6/2007 – 5/31/2007.

5) Principal-Investigator: "Property Characterization of Biodegradable Insulation Material," Funded by MXT Corp., $3,956, 03/13/2006 – 3/13/2007.

6) Principal-Investigator: "Development of Residual Stress Measurement Standards for Machining-Induced Distortion Failures", Funded by Los Alamos National Laboratory, $37,926, 01/15/2006 – 12/31/2006.

7) Principal-Investigator: “Numerical Analysis of High-Cycle Fatigue with Probabilistic Failure.” Funded by Alpha Star Corporation, $170,000, 6/1/2005 – 5/31/2006.

8) Principal-Investigator: “Effect of Dietary Lipids on Flexural Strength and Histomorphometry of Osteoporotic Animal Bone Models”. Funded by Texas Tech Multidisciplinary Seed Grant Program, $29,200, 4/01/2002- 8/01/2003.

9) Co-Investigator: “Two-year program extension, MURI-II, “Explosive-Driven Power Generation for Directed-Energy Munitions,” Funded by Air Force Office of Scientific Research, $2,000,000, 5/01/2001- 5/01/2003.

10) Co-Investigator: “MURI II, Explosive-Driven Power Generation for Directed-Energy Munitions,” Funded by Air Force Office of Scientific Research, $3,000,000, 5/01/98- 5/01/2001.

11) Principal-Investigator: "Materials Testing System”, Instron Corp., $27,320, 5/97.

12) Principal-Investigator: "Hydraulic Power Unit for Cold Expansion of Airplane Fuselage Rivet Holes”, Womack Systems. L.C., $925, 10/96.

13) Principal-Investigator: "Improving Machining of Internally Stressed Components Through Model Predictive Control," Funded by the Pittsburgh Supercomputing Center, $8,000 9/96-9/97.

14) Principal-Investigator: "Improving Machining of Internally Stressed Components Through Model Predictive Control," Funded by the Pittsburgh Supercomputing Center, $16,000 9/95-9/96.

15) Principal-Investigator: "Effective Control of Distortion and Residual Stresses Induced by Rapid Quenching" Funded by the Advanced Technology Program (ATP), Texas Higher Education Coordinating Board, $88,000, 1/96-1/98.

16) Principal-Investigator: "Design and Construction of a Scale Model 400-Ton Mechanical Press for Manufacturing Expanded Metal Grating. Funded by EMI Inc., $1,243, 8/94 - 12/94.

17) Principal-Investigator: "Achieving Optimum Material Properties While Minimizing Distortions due to Rapid Quenching," Funded by the Center for Applied Automation and Research (CFAR), $15,250, 11/93-11/94.

18) Co-Investigator: "Effect of Thermal Cycling and Space Conditions on the High Voltage Flash-Over of Dielectrics", Funded by Defense Nuclear Agency (DNA), $500,000, 1/93-1/94.

19) Co-Investigator: "Design and Manufacturing of Multi-Layered Spherical Pressure Vessels Using the Integral Hydro-Bulge Forming Method", Funded by College of

Engineering, Texas Tech University, State Line Item Research Program, $23,500, 9/92-9/93.

20) Co-Investigator: "High-Voltage Space Power Research", Funded by Defense Nuclear Agency (DNA), $250,000, 1/92-1/93.

21) Co-Investigator: "Effect of Thermal Cycling and Space Conditions on the High Voltage Flash-Over of Dielectrics", Funded by Defense Nuclear Agency (DNA), $460,000, 1/92-1/93.

22) Principal-Investigator: "Composite Materials", Funded by W.G. Composites, $60,000, 12/91.

23) Co-Investigator: "Effect of Thermal Cycling and Space Conditions on the High Voltage Flash-Over of Dielectrics", Funded by Defense Nuclear Agency (DNA), $500,000, 1/91-1/92.

24) Principal Investigator: "Experimental Measurement of Residual Stresses Due to Non-uniform Cooling Following Heat Treatment Operation", Funded by Alcoa Technical Center, $10,000, 1/91-1/93.

25) Principal Investigator: "Ultrasonic-Based Measurement of Residual Stresses Induced by Large Deformation Manufacturing Processes", Funded by Engineering Foundation, a Department of Engineering Trustees Inc., $20,000, 9/90-9/91.

26) Principal Investigator: "Equipment for Ultrasonic-Based Measurement of Residual Stresses Induced by Large Deformation Manufacturing Processes", Funded by Texas Tech University, $24,000, 6/91-6/92.

27) Co-Investigator: "Avionics Integrity: Finite Element Analysis of LRUs and PCBs Subjected to Vibration and/or Thermal Environments", Funded by General Dynamics/FW, $100,000, 1/90-1/91.

28) Principal Investigator: "Physical and Numerical Modeling of Metal-Forming Processes", Alcoa Research Foundation, $7,500, 6/89-90.

29) Co-Investigator: "An Automated Video-Optical Diffractometry Technique for Measurement of Strain on Curved Surfaces", Funded by the Advanced Technology Program (ATP), Texas Higher Education Coordinating Board, $114,000, 6/88-9/90.

30) Co-Investigator: "Development of a Beam Pump Intelligent Well Controller: Measurement of Position, Displacement and Induced Forces", Funded by Teledyne Merla Inc., $7,000, 1/89-1/90.

GRADUATE STUDENT SUPERVISSION **(Partial List)**

Student's Name	Degree Earned	Thesis/Dissertation Title
Neil Kunango Committee Chair)	M.S.M.E. Spring 2014	"Effect of UV Exposure Time and Dose Degradation of Polymeric Webbing Materials"
Andrew Schmit (Committee Chair)	M.S.M.E. Spring 2014	"Effect of Size and Fit on Energy Absorption Characteristics of Football Helmets"
Yasaman Nikpour (Committee Chair)	M.S.M.E. Summer 2012	"Performance & Characterization of Behavior of Nano Materials Under High-Strain Rate Loading"
Evan Shimek (Committee Chair) Composite	M.S.- M.E. Spring 2012	"Finite Element Computer Modeling of Damage Resulting from the High-Speed Impact of a Projectile with a Composite Target"
Clayton Moore (Committee Chair)	M.S.M.E. Fall 2011 Phase-Array Technology"	"Detection of Initiation and Progression of Fatigue Crack Growth in Aerospace Components Using
David Upshaw (Committee Chair)	M.S.- M.E. Spring 2011	"Influence of Drilling Parameters on the Accuracy" of Hole-drilling Residual Stress Measurements"
Ryan Humphrey Micro- (Committee Member)	M.S.- M.E. December 2010	"Strain-Rate Sensitivity of Strength in Macro-to- to-Nano Crystalline Nickel"
Daniel Steves and (Committee Chair)	M.S.- M.E. December 2010 Construction"	"Effect of Heat-Affected Zone on properties of 2024 Aluminum components used for Al-ladder
Dhananjay Ghatpande (Committee Chair)	M.S.- M.E. August 2010	"Experimental study of the Energy Absorption Characteristics of Football Helmets"
Archis Marathe (Committee Chair)	M.S.- M.E. August 2010	"Failure Analysis and Performance Characterization of Synthetic Rope Fibers"
Spandan Archa (Committee Chair)	M.S.- M.E. December 2009	"Analysis of Residual Stresses via Hole-Drilling and Contour Methods"
Sharath Neelakanta (Committee Chair)	M.S.- M.E. December 2009	"Experimental Study of Hail Impact Damage on Roofing Materials"

Raja Gudipati (Committee Chair)	M.S.- M.E. December 2009	"Effect of Inhibited Acid Cleaning on Fractographic features of Fracture Surfaces in AISI 1018 and AISI 1060 Steel Specimens
John Zanoff (Committee Member)	Ph.D. – M.E. December 2009	"Approach to Assessing Product Reliability"
Hutcheson, Stephen (Committee Member)	Ph.D.- CHEE, August 2008	Evaluation of Viscoelastic Materials: The Study of Nanosphere Embedment into Polymer Surfaces and Rheology of Simple Glass Formers Using a Compliant Rheometer
Dhorje, Mrugesh (Committee Member)	M.S. – M.E. August 2008	Application of Modified Weibull Failure Theory For Contact Loading
Ramkumar (Committee Chair)	Ph.D. - M.E. Dec. 2007	"High Strain-Rate and High Temperature-Rate Characterization of Material Properties"
Nathan Poerner (Committee Chair)	M.S. – M.E. Dec. 2007	"Round-Robin Study of Residual Stress Measurement Techniques"
Vipin Palande (Committee Chair)	M.S. – M.E. May 2009	"3-D Finite Element Analysis of residual Stress in Cold Expanded Holes"
Gautam Kumar (Committee Chair)	M.S.- M.E May 2005	"Failure Analysis of an Engine Bearing Cap".
Xiabin Le (Committee Chair)	Ph.D. – M.E.	"Experimental and Finite Element Analysis of Explosive Loading in MFCGs"
Nripendue Dutta (Committee Chair)	Ph.D. – M.E.	"Experimental and Finite Element Analysis of Elasto-Palstic Boundary in Cold Expanded Holes"
Ali Raja (Committee Chair)	M.S.- M.E.	"Experimental Study of Bending Fracture Stress of Rat Bones Subjected to Different Diets"

PROFESSIONAL SERVICES:

2008-2009 **12th Society for Design & Process Sciences (SDPS) Transdisciplinary Conference on Integrated Systems , Design & Process Science, May 31 – June 5, 2009, Dallas, TX**
Program Chairman

2006-2007 **10th World Conference on Integrated Design & Process Technology,** May 27- June 1, 2007, Antalya, Turkey
Member of Program Committee

2005: **National Science Foundation Grant Review Panel**
Served as a reviewer for NSF's Division of Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs covering the topics of Manufacturing and Machine Design

2001-Present: **Secretary - ASME Great International Region X**
Responsibilities included serving on ASME-Region X Operating Board and assisting the VP with the operation of region X activities

1998-2001: **Assistant VP for Education – ASME Great International Region X**
Responsibilities included serving on ASME-Region X Operating Board covering more than 50 universities in 4 states and two countries, organization of the annual ASME Regional Student Conference (RSC), Graduate Student Technical Conference (GSTC), Design Contest, as well as organization of the annual Regional Student Leadership Seminar (RSLS) for training of incoming ASME student officers

1991-Present: **ASM/TMS Student Chapter Faculty Adviser,**
Department of Mechanical Engineering, Texas Tech University.
Founded the first joint student chapter of the American Society of Materials and The Metallurgical Society (**ASM/TMS**) at Texas Tech University

1989-2002: **ASME Student Chapter Faculty Adviser,**
Department of Mechanical Engineering, Texas Tech University.
Provided support and guidance to the local student chapter of the American Society of Engineers

1998: **Society for Experimental Mechanics (SEM) Session Chairman,**
Served as the chairman for a session on "Application of Numerical Modeling to the Analysis of Residual Stresses" at the SEM's 1998 Spring Conference, June 2-4, 1998, Houston, Texas

1997: **National Science Foundation Advisory Panel**
Served as an NSF advisory panelist for the Individual Investigator Award (IIA) proposals in the Mechanics and Materials program in the Division of Civil and Mechanical System, June 9 and 10, 1997

1995-1996: **Society for Design and Process Science (SDPS) Conference Symposium Developer,**
Served as the "Materials" Symposium Chairman. Organized the "Materials" symposium at the SDPS's Second World Conference on Integrated Design & Process, held December 1-4, 1996, Austin, Texas.

1995-1996: **ASME Conference Symposium Developer,**
Served as the U.S. Symposium Chairman. Organized the "Manufacturing" symposium at the ASME's Third European joint conference on Engineering Systems Design and Analysis (ESDA), held July 1-4, 1996, Montpellier, France.

1993-1994: **ASME Conference Session Developer,**
Served as a session developer. Organized and developed a session in "Plasticity" at the ASME's Second European joint conference on Engineering Systems Design and Analysis (ESDA), held July 4-7, 1994, London, England.

1992-1994: **Society for Experimental Mechanics, Residual stress Committee**.
Served on the SEM Residual Stress Committee and helped with the organization of conference sessions, publications, and workshops.

1993: **Society for Experimental Mechanics Conference Session Developer,**
Organized and chaired a sponsored session on the "Application of Numerical Methods to the Analysis of Residual Stresses," for the 50th Annual Spring Conference of the Society for Experimental Mechanics, June 5-12, 1993, Dearborn, Michigan.

1992: **ASME Conference Session Developer,**
Served as a session developer. Organized, developed and chaired a session in "Plasticity" at the ASME's first European joint conference on Engineering Systems Design and Analysis (ESDA), June 29-July 4, 1992, Istanbul, Turkey.

1988-1989: **SAE Project Faculty Co-Adviser,**
Department of Mechanical Engineering, Texas Tech University.
Assisted in the organizing of the **SAE** National Walking Machine Decathlon Contest, held at Texas Tech in April, 1989. This is an annual robotics competition aimed at promoting interdisciplinary cooperation among undergraduate engineering students from ME, CE, EE, and CS Departments.

1991-1997: Adopt-a-Classroom Project. Assisted local high schools with engineering-related design projects and competitions that help promote the field of engineering.

1991-1993: Member of the Board of Directors of Lubbock Tennis Association (LTA).

1989-1990: Volunteer judge at the **"Math Count"** competition among local schools.

BOOK/EDITORIAL PUBLICATIONS:

1. J. Rasty, A. Ertas, and R. Couvillion, Editors, "Proceedings of the 4th Joint ASME/SDPS International Graduate Student Technical Conference", April 7-8, 2006, Fayetteville, Arkansas.

2. P. Worsey, J. Baired, and J. Rasty, Book Section: "Mechanical Aspects," Explosively Driven Pulsed Power – Helical Magnetic Flux Compression Generators, Springer Publishing, 2005, pp. 53-125.

3. J. Rasty, A. Ertas, and R. Couvillion, Editors, "Proceedings of the Third Joint ASME/SDPS International Graduate Student Technical Conference", March 31-April 2, 2005, Lubbock, TX

4. J. Rasty, A. Ertas, and R. Couvillion, Editors, "Proceedings of the Second Joint ASME/SDPS International Graduate Student Technical Conference", March 25-27, 2004, Longview, TX

5. J. Rasty, R. Couvillion, and A. Ertas, Editors, "Proceedings of the First Joint ASME/SDPS International Graduate Student Technical Conference", March 28-29, 2003, Houston, TX

6. Bellet, M., Rasty, J., Editors, "Volume 3: Composite Materials, Manufacturing, Fatigue, and Fracture," ASME Engineering Systems Design and Analysis, ASME Publishing, 1996.

7. East, I.I., Veniali, F., Rasty, J., Gransberg, D.D., Ertas, A., Editors, "Integrated Design and Process Technology," Society for Design and Process Science Publishing, 1996.

8. Rasty, J., Book Section: "Residual (Internal) Stress Considerations in Design," The Engineering Design Process, A. Ertas, and J.C. Jones, John Wiley & Sons Publishing, 1993.

JOURNAL PUBLICATIONS

9. Schmit, Evan, Rasty, J. "Effect of Size and Fit on the Energy Absorption Capability of Football Helmets", Journal of Biomechanics (under review)

10. Steinzig, Mike, Upshaw, David, Rasty, J., "Effect of Drilling Speed on Residual Stress Measurements Utilizing the Hole-Drilling Technique", J. of Experimental Mechanics (accepted)

11. Dutta, N., and Rasty, J., "Prediction of Elastic-plastic Boundary around Cold-expanded Holes Using Elastic Strain Measurement", J. of Engineering Materials Technology, July 2010, Vol. 132, Issue 3

12. Baydogan, M., Cimenoglu, E., Kayali, S., and Rasty, J., "Improved Resistance to Stress-Corrosion Cracking Failures via Optimized Retrogression and Re-Aging of 7075T6Aluminum Sheets, Journal of Metallurgical Transactions A, Volume 39, Number 10, October, 2008, pp. 2470-2476

13. Shen, C.L, Yeh, J.K., Rasty, J., Chyu, M.C., Dunn, D.M., Li, Y., Watkins, B.A., "Improvement of Bone Quality in Gonad-Intact Middle-Aged Male Rats by Long-Chain n-3 Polyunsaturated Fatty Acid", J. of Calcification Tissue International, Vol. 80, April 2007, , pp 286-293

14. Rasty, J., Le X.., Baydogan, M., and Cardenas-Garcia, J.F., "Measurement of Residual Stresses in Neuclear-grade ZR-4(R) Tubes: Effect of Heat Treatment," Journal of Experimental Mechanics, Vol.47, Iss. 2, Apr. 2007, pp. 185-199.

15. Yanzhang Ma, Jianjun Liu, Chun-Xiao Gao, Allen White, W. N. Mei, and Jahan Rasty, "High-pressure X-ray diffraction study of the giant dielectric constant material CaCu3Ti4O12: evidence of stiff grain surface", Applied Physics Letters, Vol. 88, 191903, May 2006.

16. Chwan-Li Shen, James K. Yeh, Jahan Rasty, Yong Li, and Bruce A. Watkins, "Protective effect of dietary long chain n-3 PUFA on bone loss in intact middle-aged male rats," British Journal of Nutrition, Vol. 95, No. 3, March 2006, pp. 462-468.

17. Barry J. Henry, MD, Mike Kenison, BS, Catherine McVay, PhD, Rial Rolfe, PhD, Suzanne Graham, MD, Jahan Rasty, PhD, James Slauterbeck, MD, Eugene J. Dabezies, MD, "The Effect of Local Hematoma Blocks on Early Fracture Healing," *Feature Article in the Journal of Orthopedics*, Vol. 25, No. 11, November 2002, pp. 1259-1262.

18. Sofuoglu, H., Gedikli, H., Rasty, J., "Determination of Friction Coefficient by Employing the Ring Compression Test," ASME Transactions - Journal of Engineering Materials and Technology (JEMT), Vol. 123, issue 3, July 2001, pp. 338-348.

19. Sofuoglu, H., Rasty, J., "Flow Behavior of Plasticine used in Physical Modeling of Metal Forming Processes," Journal of Tribology International, Vol. 33, Issue 8, October 2000, pp. 523-529.

20. Sofuoglu, H., Rasty, J., "On the Measurement of Friction Coefficient Utilizing the Ring Compression Test" Journal of Tribology International, Vol. 32, Issue 6, January 2000, pp.

21. Rasty, J., Kolarik, W., and Chen, B.M., "Designing Surface Mounted Components for High Reliability," Journal of Energy Resources Technology, Vol. 116, No. 3, September 1994, pp. 232-239.

22. Rasty, J., and Tamhane, P., "Application of the Finite Element Method to the Quasi-Static Thermoelastic Analysis of Prestress in Multilayer Pressure Vessels," ASME Transactions, Journal of Pressure Vessel Technology, Vol. 116, No. 3, August 1994, pp. 254-260.

23. Hashemi, J., Rasty, J., Li, S., and Tseng, A.A., "Integral Hydro-Bulge Forming of Single and Multi-Layered Spherical Pressure Vessels," ASME Transactions, Journal of Pressure Vessel Technology, Vol. 115, No. 3, August 1993, pp. 249-255.

24. Sofuoglu, H., Rasty, J., "3-D Simulation of the Extrusion Process Utilizing the Physical Modeling Technique," Journal of Energy Sources Technology. Vol. 115, No. 1, March 1993, pp. 32-40.

25. Rasty, J. and Chapman, D., "Isothermal and Thermomechanical Finite-Element Analysis of the Tube Drawing Process Utilizing a Fixed, Tapered Plug," Journal of Materials Engineering and Performance, Vol. 1, No.4, August 1992, pp. 547-554.

26. Rasty, J. and Sabbaghian, M., "The Effect of Imperfect Contact between Adjacent Layers on the Integrity of Multilayered Wrapped Vessels," Journal of Pressure Vessel Technology, Transactions of the ASME, Vol. 110, No. 3, August 1988, pp. 247-254.

<u>CONFERENCE PUBLICATIONS & PRESENTATIONS</u>:

1. Rasty, J., "Experimental and Computer-Aided Assessment of Damage to Galvanized Steel due to Hail Impact", National Academy of Forensic Engineers Annual Conference, Jan 4-7, 2012, Miami, FL

2. E. Shimek, S. Ekwaro and J. Rasty, “Probabilistic Analysis of Steel Roof Damage from Hail Strike”, ASME International Mechanical Engineering Congress & Exhibition, November 11-17, 2011, Denver, Colorado

3. Jahan Rasty and Archis Marathe, “Effect of Material Composition and Failure Mode on Treatment of Corroded Fracture Surfaces for Optimal Fractography,” ASME International Mechanical Engineering Congress & Exhibition, November 12-18, 2010, Vancouver, British Columbia,

4. Xiaobin Le and Jahan Rasty, “A probabilistic Approach to Determination of Component Dimensions under Fatigue Loading,” Proceedings of ASME 2009 International Design Engineering Technical Conferences, IDETC, August 30-September 2, 2009, San Diego, CA,

5. Nathan Poerner, Jahan Rasty and Mike Steinzig, “Round Robin Study of Residual Stress Measurement Techniques,” 3rd International residual Stress Summit, October 2-4, 2007, Oak Ridge National Laboratory, Oak Ridge, TN.

6. Nathan Poerner, and Jahan Rasty, "Effect of Cutting Method on Residual Stress Measurement via Slitting Technique," Society for Experimental Mechanics (SEM) Annual Conference, June 3-6, 2007, Springfield, Massachusetts,

7. R. Srinivasan,, and J. Rasty, "Prediction and Measurement of Residual Stresses in Extruded and Drawn Rods and Tubes," The Minerals, Metals & Materials Society (TMS) 2007 Annual Meeting & Exhibition, February 25 – March 1, 2007, Orlando, Florida,

8. J. Rasty, and X. Le, "Does Hail Damage Constitute Material Failure? An Experimental and Finite Element Study of Hail-induced Damage in Metallic Roofing Materials," 2nd International Conference on Engineering Failure Analysis, September 13-15, 2006, Toronto, Canada.

9. J. Rasty, and H. Sari-Sarraf, "Application of X-Ray Tomography, Light and Scanning Electron Microscopy to Failure Analysis of a Fill-Valve Coupling Nut," 2nd International Conference on Engineering Failure Analysis, September 13-15, 2006, Toronto, Canada.

10. Murat Baydoğan, Hüseyin Çimenoğlu, E. Sabri Kayalı, and Jahan Rasty, "Effect of Retrogression and Re-aging Treatment on Stress Corrosion Cracking Resistance of 7075 Aluminum Alloy", Proceedings of the 135th TMS (The Minerals, Metals & Materials Society) Conference, March 12-16, 2006, San Antonio, TX.

11. Yanzhang Ma, Jianjun Liu, Chun-Xiao Gao, Allen White, W. N. Mei, and Jahan Rasty, "High-pressure X-ray diffraction study of the giant dielectric constant material CaCu3Ti4O12: evidence of stiff grain surface", 2006 American Physical Society (APS) March Meeting, March 13–17, 2006; Baltimore, MD.

12. J. Rasty, M. Baydogan, K. Ramkumar, and J.F. Cardenas-Garcia, "Measurement of Residual Stresses in Nuclear-Grade Zircaloy–4(R) Tubes – Effect of Heat Treatment," 2nd Residual Stress Summit, August 10-12, 2005, Vancouver, Canada.

13. K.V. Ramkumar, and J. Rasty, "Effect of Combined Corrosion and Residual Stress on Fatigue Failure", proceedings of the 2004 Society for Experimental Mechanics (SEM) X International Congress, June 7-10, 2004, Costa Mesa, California.

14. J.F. Cardenas-Garcia, and J. Rasty, "The Indentation Test Revisited: Obtaining Poisson's Ratio", proceedings of the 2004 Society for Experimental Mechanics (SEM) X International Congress, June 7-10, 2004, Costa Mesa, California.

15. Chawn-Le Shen, Dale M. Dunn, James, K. Yeh, Bruce A. Watkins, Yong Li, Ali Raja, and Jahan Rasty, "Dietary n-3 Polyunsaturated Fatty Acids Prevent Aging-induced Bone Loss in Male Rats." To be presented at the Experimental Biology Conference, Washington D.C., April 2004.

16. David Hemmert, John Mankowski, Jahan Rasty, Andreas Neuber, Xiaobin Le, James Dickens, and Magne Kristiansen, "Conductivity Measurements of Explosively Shocked Aluminum and OFHC Copper Used for Armature Material in a Magnetic Flux Compression Generator," Presented at the Pulsed Power Conference, Dallas, Texas, June 16-18, 2003.

17. Jahan Rasty and Xiaobin Le, James Dickens, Andreas Neuber, and Magne Kristiansen, "Design Criteria for Prevention of Armature Turn-Skipping in Helical Magnetic Flux Compression Generators," Presented at the Pulsed Power Conference, Dallas, Texas, June 16-18, 2003.

18. Rasty, J., Le, X., Neuber, A., Dickens, J., Kristiansen, M. "Micro structural Evolution of the Armature Material Subjected to Explosive Shock-Loading in Magnetic Flux Compression Generators," Proceedings of the Ninth International Conference on Megagauss Magnetic Field Generation and Related Topics, Moscow-St. Petersburg, Russia, July 7-14, 2002, pp. 197-201.

19. Rasty, J., Le, X., Neuber, A., Dickens, J., Kristiansen, M. "Effect of Scaling on Armature Expansion Angle in Magnetic Flux Compression Generators," Proceedings of the Ninth International Conference on Megagauss Magnetic Field Generation and Related Topics, Moscow-St. Petersburg, Russia, July 7-14, 2002, pp. 191-196.

20. Rasty, J., Le, X., "Failure Analysis of the Rear Axles in a Sports Utility Vehicle (SUV)," Symposium on Failure Analysis and Prevention, 2001 ASME International Mechanical Engineering Congress & Exposition, New York, NY, November 11-16, 2001.

21. Rasty, J., Le, X., Neuber, A., Dickens, J., and Kristiansen, M." Experimental and Numerical Investigation of the Armature/Stator Contact in Magnetic Flux Compression Generators," Proceedings of the 28th IEEE International Conference on Plasma Science, Las Vegas, Nevada, June 17-22, 2001

22. Le, X., Rasty, J., Neuber, A., Dickens, J., and Kristiansen, M." Calculation of Air Temperature and Pressure History During the Operation of a Flux Compression Generator," Proceedings of the 28th IEEE International Conference on Plasma Science, Las Vegas, Nevada, June 17-22, 2001

23. Hemmert, D., Rasty, J., Le, X., Neuber, A., Dickens, J., and Kristiansen, M." Conductivity Measurements of MFCG Armature Material Under Shock and High Strain Rates Utilizing a Split-Hopkinson Pressure Bar Apparatus," Proceedings of the 28th IEEE International Conference on Plasma Science, Las Vegas, Nevada, June 17-22, 2001.

24. Neuber, A., Dickens, J., Giesselmann, M., Freeman, B., Rasty, J., Le, X., Krompholz, H., and Kristiansen, M." Fundamental Studies of a Simple Helical Magnetic Flux Compression Generator ," Proceedings of the 27th IEEE International Conference on Plasma Science, New Orleans, LA, June 4-7, 2000.

25. Rasty, J., Le, X., Neuber, A., Zhang, J., Dickens, J., "Measurement of Dynamic Electrical Conductivity of MFCG Armature Material under Conditions of Shock and High Strain Rate Loading," Proceedings of the 12th IEEE International Pulsed Power Conference, June 27-30, 1999, Monterey, CA, pp. 708-711.

26. Dutta, N., Rasty, J., "Determination of Elastic-plastic Boundary around Cold-expanded Holes Using Elastic Strain," Proceedings of the 1999 Society for Experimental Mechanics (SEM) Spring Conference, June 7-9, 1999, Cincinnati, Ohio.

27. Dutta, N., Rasty, J., and Rassaian, M., "Evolution of Internal Stresses in Co-Drawing Bimetallic Rods," Proceedings of the 1998 Society for Experimental Mechanics (SEM) Spring Conference, June 1-3, 1998, Houston, Texas.

28. Dutta, N., Rasty, J., and Rassaian, M. "Finite Element Analysis of Elastic-Plastic Zone Around Cold-Expanded Holes," Post-Conference Proceedings of the 1997 Society for Experimental Mechanics (SEM) Spring Conference, June 2-5, 1997, Bellevue, Washington, pp. 108-115.

29. Rasty, J., Dutta, N., Dehghani, M., and Rassaian, M. "Finite Element Analysis of Residual Stresses and Interface Shear Strength in Co-Drawing of Tubular Components," proceedings of the 1997 Society for Experimental Mechanics (SEM) Spring Conference, June 2-5, 1997, Bellevue, Washington.

30. Rasty, J. and Sofuoglu, H., *" On the Measurement of Friction Coefficient Utilizing the Ring Compression Test: Part II - Effect of Deformation Speed, Strain Rate and Barreling," Proceedings of the 1996* ***ASME*** *European Joint Conference on **E**ngineering **S**ystems **D**esign and **A**nalysis* ***(ESDA),*** *Symposium on Manufacturing,* July 1-4, 1996, Montpellier, France, PD-Vol. 75, pp. 189-197.

31. Rasty, J., H. Shin, "The Effect of Machining Operations on Changes in Curvature and Redistribution of Residual Stresses," *Proceedings of the 1995 ASME/Winter Annual Meeting - Symposium on Recent Advances in Structural Mechanics,* November 12-17, 1995, San Francisco, CA, PVP-Vol. 321/NE-Vol.18, pp. 65-78.

32. Sofuoglu, H., and Rasty, J. *" On the Measurement of Friction Coefficient Utilizing the Ring Compression Test: Part I - Effect of Material Properties," Proceedings of the 1994* ***ASME*** *European Joint Conference on **E**ngineering **S**ystems **D**esign and **A**nalysis (**ESDA),** Symposium on Design: Analysis, Synthesis, and Applications,* July 4-7, 1994, London, England, PD - Vol. 64-8.1, pp. 55-62.

33. Rasty, J. "Application of the Sach's Boring-out and Finite Element Techniques to the Measurement of Residual Stresses In Oxygen-free High Conductivity Copper Tubes," First International Conference on Processing Materials for Properties, November 7-10, 1993, Honolulu, Hawaii.

34. Rasty, J. "Application of FEM to the Analysis of Tube Drawing Process: I) Effect of Temper on Drawing and Residual Stresses," Proceedings of the Society for Experimental Mechanics, 1993 Spring Conference, June 6-11, 1993, Dearborn, Michigan, pp. 233-247.

35. Rasty, J., Hunter, D., and Roy, G. "Application of ABAQUS and ADINA Finite Element Codes to the Analysis of Residual Stresses Induced by Rapid Quenching," *Proceedings of the Society for Experimental Mechanics,* 1993 Spring Conference, June 6-11, 1993, Dearborn, Michigan, pp. 205-213.

36. Rasty, J., Hashemi, J., Hunter D.E. and Dehghani, M., "Finite Element and Experimental Analysis of Stresses due to Quenching Process," *Proceedings of the 1992 ASME/Winter Annual Meeting - Symposium on Computational Methods in Materials Processing,* November 8-13, 1992, Anaheim, California, MD-Vol. 39 / PED-Vol.61, pp. 195-202.

37. Jiang, W., Dehghani, M., and Rasty, J. "An Investigation of Hydroforming of Sheet Metals with Varying Blankholding Loads," *Proceedings of the 1992 ASME/Winter Annual Meeting - Symposium on Computational Methods in Materials Processing,* November 8-13, 1992, Anaheim, California, MD-Vol. 39 / PED-Vol.61, pp. 87-96.

38. Hashemi, J., Rasty, J., and Tseng, A.A. "Application of the Integrated Hydro-Bulge Forming Process to the Manufacturing of Multilayered Spherical Pressure Vessels," *Proceedings of the 1992 ASME/Winter Annual Meeting - Symposium on Recent Advances in Structural Mechanics,* November 8-13, 1992, Anaheim, CA, PVP-Vol. 248 / NE-Vol.10, pp.73-79.

39. Sofuoglu, H., and Rasty, J., "Three Dimensional Physical Modeling of Extrusion Process," ***ASME*** *European Joint Conference on* ***E****ngineering* ***S****ystems* ***D****esign and* ***A****nalysis,* ***ESDA,*** June 29-July 3, 1992, Istanbul, Turkey. ASME - PD - Vol. 47-1, pp. 377-386

40. Rasty, J., Hashemi, J., Hunter, D., and Roy, G., "Quenching-Induced Residual Stresses in Forged 7150-Aluminum Blocks," *Proceedings of the Society for Experimental Mechanics,* Spring Conference, June 8-11, 1992, Las Vegas, Nevada. pp. 756-765

41. Rasty, J. and Farahaninia, K., "Internal Stress Distributions Resulting From Cold Drawing of Aluminum Tubes," *Proceedings of the Society for Experimental Mechanics,* Spring Conference, June 8-11, 1992, Las Vegas, Nevada. pp. 1793-1801.

42. Rasty, J., Kolarik, W., and Chen, B., "Designing Surface Mounted Components for High Reliability," *Proceedings of the 1992 ASME Energy-Sources Technology Conference, Dynamics and Vibrations Symposium,* January 26-29, 1992, Houston, Texas, ASME-PD-Vol. 44, pp. 41-52.

43. Kolarik, W., Rasty, J., Chen, B., and Kim, Y., "Electronics/Avionics Integrity: Definition, Measurement and Improvement," *Proceedings of the 1992 Annual Reliability & Maintainability Conference,* January, 1992, Las Vegas, Nevada, pp. 460-467.

44. Rasty, J. and Pushkar, T., "Application of the Finite Element Method to the Quasi-Static Thermoelastic Analysis of Prestress in Multilayer Pressure Vessels," *Proceedings of the 1991 ASME/Winter Annual Meeting - Pressure Vessel and Piping Symposium,* December 1-6, 1991, Atlanta, Georgia. ASME-PVP-Vol. 225 / NE-Vol. 7, pp. 95-102.

45. Rasty, J. and Chapman, D., "Effect of Process Variables on the Tube Drawing Process and Product Integrity," *Proceedings of the 1991 ASME/Winter Annual Meeting,* December 1-6, 1991, Atlanta, Georgia, ASME-PVP-Vol. 225 / NE-Vol. 7, pp. 81-94.

46. Rasty, J. and Hartley, C. S., "Effect of Various Degrees of Cold Working on the Residual Stress Patterns of Drawn OFHC Copper Tubes," *Proceedings of the Society for Experimental Mechanics,* Spring Conference, June 9-13, 1991, Milwaukee, Wisconsin, pp. 392-404.

47. Rasty, J., Husband, M., Eggleston, E., and McCrea, A., "Experimental Measurement of Residual Stresses Induced by Nonuniform Cooling of Aluminum Blocks," *Sixty-Seventh Annual Southwestern and Rocky Mountain Division Symposium, SWARM,* May 15-18, 1991, Lubbock, Texas.

48. Rasty, J., Alcouffe, D., and Handy, S., "Effect of Friction on Physical Modeling of Extrusion Process," *Sixty-Seventh Annual Southwestern and Rocky Mountain Division Symposium, SWARM,* May 15-18, 1991, Lubbock, Texas.

49. Rasty, J. and Hartley, C. S., "A Parametric Study of the Tube Drawing Process Utilizing the Finite Element Method," *Proceedings of the 1990 Pacific Conference on Manufacturing,* December 17-21, 1990, Sydney and Melbourne, Australia, pp. 243-254.

50. Rasty, J. and Sofuoglu, H., "On the Validity of Using PLASTICINE in Physical Modeling of Metalworking Processes," *Proceedings of the Society for Experimental Mechanics, Spring Conference,* June 3-6, 1990, Albuquerque, New Mexico, pp. 638-640.

51. Rasty, J. and Sofuoglu, H., "Flow Characteristics of Various Types of PLASTICINE Used in the Physical Modeling Technique," *Proceedings of the Society for Experimental Mechanics, Spring Conference,* June 3-6, 1990, Albuquerque, New Mexico, pp. 34-43.

52. Rasty, J. and Hartley, C. S., "Determination of Residual Stresses in Drawn OFHC Copper Tubes Using Electrochemical Machining (ECM)," *Proceedings of the Society for Experimental Mechanics,* Spring Conference, May 28-June 1, 1989, Cambridge, Massachusetts, pp. 893-900.

53. Rasty, J. and Cardenas-Garcia, J. F., "Development of a Walking Machine - A Tool for Promoting Interdisciplinary Cooperation Among Undergraduate Engineering Students," *Proceedings of the ASEE Gulf-Southwest Conference,* April 2-4, 1989, Lubbock, Texas, pp. 324-331.

54. Cardenas-Garcia, J. F., and Rasty, J., "An Automated Video Optical Diffractometry Technique for Measurement of Strain on Curved Surfaces," Texas Research Seminars Conference, April 24-25, 1989, Dallas, Texas.

55. Cardenas-Garcia, J. F., Rasty, J. and Moulder, J. C., "NDE Applications of an Optical Technique for Noncontact Measurement of In-Plane Strains," *Proceedings of Review of Progress in Quantitative NDE,* University of California, San Diego, La Jolla, California, August 1-5, 1988, pp. 768-779.

56. Rasty, J. and Hartley C. S., "Experimental Measurement of Residual Stresses in Nuclear-Fuel Cladding," *Proceedings of the Society for Experimental Mechanics, Spring Conference,* June 19-23, 1986, New Orleans, Louisiana, pp. 254-263.

57. Rasty, J. and Sabbaghian, M., "The Effect of Imperfect Contact Between Adjacent Layers on the Integrity of Multilayer Wrapped Vessels," *Proceedings of the 1985 ASME/Pressure Vessels and Piping Conference,* New Orleans, Louisiana, June 23-26, 1985, PVP-Vol. 98-8, pp. 167-176.

INVITED LECTURES:

1) "Application of Engineering Principles to Forensic Investigations", Texas Tech Institute for Forensic Sciences, Sep 27, 2011, Lubbock, Texas

2) "Recent Research Projects in Root-cause Failure Analysis Techniques & Methodology", South Plains Chapter of National Society of Professional Engineers, Jan 18, 2011, Lubbock, TX

3) "Forensic Engineering Principles", Guest Lecturer, Texas Tech Institute for Forensic Sciences, Sep.-Dec. 2010, Lubbock, Texas

4) Principles of Failure Analysis and Solid Mechanics", Raytheon Corporation, October 4-5, 2007, Garland, Texas.

5) "Mechanics of Materials & Failure Analysis", Raytheon Corporation, October 13-14, 2006, Dallas, Texas

6) "Foundations of Engineering Principles: Statics, Dynamics, Materials, Solid Mechanics", Raytheon Corporation, October 14-15, 2005, Dallas, Texas

7) "Principles of Forensic Engineering", 2005 Caprock Crime Scene Investigators (CSI) Camp. The Institute for the Development and Enrichment of Advanced Learners (IDEAL), June 30, 2005, Lubbock, TX

8) "Principles of Forensic Engineering", 2005 Caprock Crime Scene Investigators (CSI) Camp. The Institute for the Development and Enrichment of Advanced Learners (IDEAL), June 30, 2005, Lubbock, TX

9) “Foundations of Engineering Principles: Statics, Dynamics, Materials, Solid Mechanics”, Raytheon Corporation, October 15-16, 2004, Dallas, Texas

10) “Foundations of Engineering Principles: Statics, Materials, Solid Mechanics”, Raytheon Corporation, October 16-18, 2003, Dallas, Texas

11) “Engineering Principles: Statics, Materials, Solid Mechanics”, Raytheon Corporation, October 17-19, 2002, Dallas, Texas

12) "Materials Mechanics & Failure Analysis", Raytheon Corporation, October 11-13, 2001, Dallas, Texas

13) "Design Through Failure Analysis", Raytheon Corporation, March, 20-22, 2000, Dallas, TX

14) "Design Through Failure Analysis", Raytheon Corporation, March, 17-19, 1999, Dallas, TX

15) "Failure Analysis Techniques", Raytheon Corportation, Nov. 7-8, 1998 Dallas, Texas

16) "Design Through Failure Analysis", Texas Instruments, April 13-15, 1998, Dallas, Texas

17) "Design Through Failure Analysis", Texas Instruments, Sep. 7-8, Oct. 10-11, Nov. 6-7, and Dec. 10-12, 1997, Dallas, Texas

18) "Materials Research Issues in Aerospace Industry," Lockheed Martin Corporation, Oct. 11, 1996, Forth Worth Texas

19) "Measurement of Residual Stresses Induced by Nonuniform Cooling of Aluminum Blocks," Alcoa Technical Center, August 21-22, 1991, Alcoa Center, Pennsylvania

20) "Finite Element Analysis of Avionics Microelectronics Subjected to Thermal and Vibrational Environments," General Dynamics, December 11, 1990, Fort Worth, Texas

21) "Effect of Friction on the Physical Modeling of Metal Forming Processes," ASME Winter Annual Meeting, November 25-30, 1990, Dallas, Texas

22) "Finite Element Analysis of Avionics Microelectronics Subjected to Thermal and Vibrational Environments," General Dynamics, September 24, 1990, Fort Worth, Texas

23) "Residual Stress Analysis via Experimental, Physical Modeling and Finite Element Techniques," Alcoa Technical Center, June 17-18, 1990, Alcoa Center, Pennsylvania

24) "Current Research Activities in Residual Stress Analysis and Experimental Mechanics at Texas Tech University," Alcoa Technical Center, May 9-10, 1989, Alcoa Center, Pennsylvania

25) "Analytical and Experimental Measurement of Residual Stresses in Nuclear Fuel Cladding," Pratt & Whitney Research and Development Center, United Technologies, July 11-12, 1987, West Palm Beach, Florida

26) "Effective Computer Modeling and Experimental Measurement of Residual Stresses," Shell Oil Company, Westhallow Research Center, August 14-15, 1987, Houston, Texas

27) "On the Applicability of the Finite Element Methods to the Simulation of Metal Forming Processes," Inland Steel Inc., Research & Development Division, November 17-18, 1987, West Chicago, Indiana

Appendix B

Testimony History of Prof. Jahan Rasty (2010-2014)

Professor Jahan Rasty – Testimony History (2010-2014)

2014

- *Speed Montoya, Belen Rodriguez Montoya & Juan Rodriguez v. Steven Land & Brittney Land* No. 101-019-2:County Court At Law #2 for Potter County, TX (Court Testimony)

- *Speed Montoya, Belen Rodriguez Montoya & Juan Rodriguez v. Steven Land & Brittney Land* No. 101-019-2:County Court At Law #2 for Potter County, TX (Deposition Testimony)

- *Michael Wiley v. Rockford Systems, Inc. & Sick, Inc*. No. 4:12-CV-104-Y: United States District Court for the Northern District of Texas Forth Worth (Deposition Testimony)

- *Mustafa Kladusak v. Tyson Fresh Meats, Inc.* No.101,056-D: In the 320th District Court, In and For Potter County, Texas (Deposition Testimony)

2013

- *Michael Wiley v. Rockford Systems, Inc. & Sick, Inc.* No. 4:12-CV-104-Y: United States District Court for the Northern District of Texas Forth Worth (Deposition Testimony)

- *Beryl Bertrand v. Cordiner Enterprises,* No. ST-08-cv-457; In Superior Court of the Virgin Islands (Deposition Testimony).

- *Brian Doogan v. Union Pacific Railroad Company,* No. 12-cv-01148: In the United States District Court for the Southern District of Illinois (Deposition Testimony).

- *Maddison Visual Media, L.P. f/k/a/ Maddison LLP v. Tiffin Metal Productions Co.,* No. 1:11-CV-554: In the United States District Court Eastern District of Texas Beaumont Division (Deposition Testimony).

- *Elwood Mitchell Autry v. Air Tractor, Inc.*: No. 10,347; In 110th District Court of Floyd County, Texas (Deposition Testimony).

- *Chris Young v. Rio Brazos Cattle Feeders, LLC*: No. 6939; In the 100th District Court of Donley County, Texas (Deposition Testimony).

- *Charlie Pena v. Scrips, Inc. d/b/a Massage Warehouse*: No. D-101-CV-2011-02820; In the First Judicial District Court, County of Santa Fe, State of New Mexico (Deposition Testimony).

- *Patrizia Reed v. Summit Treestands, LLC:* Cause No. 10-06-05909-CV; In the District Court for Montgomery County, Texas, 284th Judicial District (Deposition Testimony).

2012

- *The State of Texas v. Robert Monroe Babcock:* Cause No. 3738; In the 100th Judicial District Court in and for Donley County, Texas (Court Testimony).

- *ABC Rental Tools, Inc., and Eunice Well Servicing Co. v. Heritage Standard Corporation:* Case No. 10-36484-hdh-11, Adversary Proceeding No. 10-03420; In the United States Bankruptcy Court for the Northern District of Texas, Dallas Division (Deposition Testimony).

- *Sammy Mark Hunter and Queenie Mae Turner Hunter v. Saint-Gobain Abrasives, Inc. d/b/a Norton, Norton S.G., and/or Norton Abrasives*: Civil Action No. 3:08-CV-0963; In the United States District Court for the Western District of Louisiana, Monroe Division (Deposition Testimony).

- *Heritage Consolidated, LLC, et al., Debtors. Heritage Standard Corp,; Pat Howell, LLC; and Heritage Consolidated, LLC, v. Apollo Perforators, Inc.*: Case No. 10-36484-hdh-11; In the United States Bankruptcy Court for the Northern District of Texas, Dallas Division (Court Testimony).

- *Sammy Mark Hunter and Queenie Mae Turner Hunter v. Saint-Gobain Abrasives, Inc. d/b/a Norton, Norton S.G., and/or Norton Abrasives*: Civil Action No. 3:08-CV-0963; In the United States District Court for the Western District of Louisiana, Monroe Division (Court Testimony).

2011

- *Heritage Consolidated, LLC, et al., Debtors. Heritage Standard Corp,; Pat Howell, LLC; and Heritage Consolidated, LLC, v. Apollo Perforators, Inc.*: Case No. 10-36484-hdh-11; In the United States Bankruptcy Court for the Northern District of Texas, Dallas Division (Deposition Testimony).

- *Jose Garcia v. Wheelabrator Group, Inc. f/k/a and d/b/a The Wheelabrator Corporation*: Case No. 3:CV-10-1253-P; In the United States District Court for the Northern District of Texas, Dallas Division (Deposition Testimony).

- *Sammy Mark Hunter and Queenie Mae Turner Hunter v. Saint-Gobain Abrasives, Inc. d/b/a Norton, Norton S.G., and/or Norton Abrasives*: Civil Action No. 3:08-CV-0963; In the United States District Court for the Western District of Louisiana, Monroe Division (Deposition Testimony).

- *Edward Farias v. Yates Construction, Commercial Concrete, Inc. and Shawn R. Usherwood*; No. 2010-551, 286; In the District Court for Lubbock County Texas 99th Judicial District (Deposition Testimony).

- *Oscar Conde, Individually, Cecilia Conde, Individually and as Next Friend of Sikeiry Conde and Sophia Mendez. v. XTO Energy, Inc.; Production Downhole Services, Inc.; and Roger Grant*: Cause No. 10-03-22052; In the District Court for Hockley County Texas 286th Judicial District (Deposition Testimony).

- *Damon Chappell and Kimberly Chappell, Plaintiffs, v. William Allen dba Double A Setters and William Scotsman., Inc.*; Cause No. 2006-4510; In the 210th District Court; El Paso County, Texas (Court Testimony).

2010

- *Cedrick Wayne Jackson, Sr., et al. v. Supreme Corporation, et al.*; Docket No. 5:09-CV-00421; United States District Court; Western District of Louisiana; Shreveport Division. (Court Testimony).

- *Icon Health & Fitness, Inc., a Delaware corporation, Plaintiff, v. Octane Fitness LLC, a Minnesota limited liability company, Defendant.*; Case No. 0:09-cv-00319 (ADM/SRN); In the District Court District of Minnesota; 4th Division (Deposition Testimony).

- *Antonio Avila, Plaintiff, v. Burrows Enterprises, Inc., Defendant.*; Case No.: 96,970-A, In the District Court Potter County, Texas 47th Judicial District (Deposition Testimony).

- *Ash, et al. v. United Plumbing, et al.*; Cause No. 97,585-D; In the 320th District Court in and for Potter County, Texas (Deposition Testimony). *Donald Kinser, Plaintiff, v. Raj Singh d/b/a Ramada Inn de Las Cruces, Defendant*.; Case No. D-307-cv-200701373; In the State of New Mexico 3rd Judicial District Court of Las Cruces (Deposition Testimony).

- *Cedrick Wayne Jackson, Sr., et al. v. Supreme Corporation, et al.*; Docket No. 5:09-CV-00421; United States District Court; Western District of Louisiana; Shreveport Division. (Deposition Testimony).

- *Mark N. Musial, in his capacity as the Administrator of the Estate of James Surrena, Deceased, and Samantha Dolinsky, as Next Friend of Jacob Anthony David Dolinsky v. PTC Alliance Corporation, Jon Doe (person responsible for loading trailer, Keith Gilkey, Great American Lines, Inc., Fontaine Trailer Company, and Unknown Defendants.*; Civil Action No. 08- CI-00269; In the Commonwealth of Kentucky; Christian Circuit Court; Third Judicial District, Division II (Deposition Testimony).

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Attorneys for Plaintiff

UNITED STATES DISTRICT COURT

CENTRAL DISTRICT OF CALIFORNIA, WESTERN DIVISION

SPARKS LANDEN, individually and on behalf of all others similarly situated,

Plaintiff,

v.

ELECTROLUX HOME PRODUCTS, INC., a Delaware Corporation; CARLSONS APPLIANCES, INC. a California Corporation; and DOES 1 through 20, inclusive,

Defendant

Case No.: CV13-01033-DSF (SHx)

DECLARATION OF RONALD L. PARSONS IN SUPPORT OF PLAINTIFF'S MOTION FOR CLASS CERTIFICATION

Hearing:
Date: June 30, 2014
Time: 1:30 p.m.
Ctrm: 840

Trial Date: None Set
Scheduling Conf.: To Be Set Upon Ruling
Complaint Filed January 8, 2013

I, RONALD L. PARSONS, declare as follows:

1. I have been retained by Plaintiff in the above reference matter filed against Electrolux Home Products, Inc. ("Electrolux"). If called as a witness, I would competently testify as to the matter set forth in this declaration.

2. I have reviewed Plaintiff's Notice of Motion and Motion For Class Certification ("Plaintiff's Motion") and documents filed therewith, along with Defendant Electrolux Home Products, Inc.'s Opposition To Plaintiff Sparks Landen's Motion For Class Certification (the "Opposition") and the documents filed therewith.

3. I attended Fitchburg State College in Fitchburg, Massachusetts for two years. I studied in the Industrial Arts Program. The Industrial Arts Program was the precursor for teaching industrial vocational education. The Industrial Arts Program consisted of metalworking, welding, joining, woodworking, materials, and communications.

4. I have a Masters Certification from the National Institute of Automotive Service Excellence in automotive technology. The pre-qualifier for the ASE certification requires training, education, and experience. Upon completing the prerequisites, exams are given for every level of certification. Currently, there are approximately 330,000 certified individuals through ASE. Currently, I have obtained 47 individual certifications which makeup the masters certification program. Only three individuals in the history of ASE have ever reached this level of certification. In order to remain ASE certified, the ASE certifications must be retested every five years, in order to stay up to date on the ever-advancing automotive technology. I have continually maintained my certifications through the ASE five-year examination policies.

5. The National Institute for Automotive Service Excellence is supported by the Society of Automotive Engineers, all American automotive manufactures, professionals, aftermarket manufacturers and educators. My extensive training and

certification through the National Institute of Automotive Service Excellence is my basis for the basic engineering disciplines in electrical, mechanical, and hydraulic disciplines. The design analysis of automotive systems requires the knowledge of multiple engineering disciplines.

6. The issue to be addressed in the subject case is whether the design componentry identified below is adequate. The design componentry at issue is componentry specifically designed to transfer liquid and gas via an air hose from point A to point B. This transfer of liquid and gas via an air hose is a common design issue in multiple vehicle systems. I am specifically knowledgeable both with regard to vehicle systems and washing machine systems that transfer liquid and gas mixtures from point A to point B via air hoses.

7. I am currently employed by the Wright Group, Inc. as an origin and cause analyst, design analyst, and mechanical failure analyst. I have been in the field of origin and cause analysis, design analysis, as well as a mechanical failure analysis for 35 years. As part of my responsibilities at the Wright Group, Inc., I analyze the designs of products and their electrical and mechanical control and safety devices, and the failure modes for these controls, devices and components. Due to my experience analyzing the designs of products, including home appliances, as they relate to failure modes and analyzing mechanical failures of electrical and mechanical components, including components in home appliances, I have experience and expertise with basic engineering and design principles. Since 2006, I have been the manager of the Engineering and Technical staff at the Wright Group, Inc. Additionally, I manage the Wright Group, Inc.'s water-based mechanical laboratory, which has inspected and analyzed over a thousand water-based appliances for water-related failures. Since my employment at the Wright Group, Inc., I have analyzed appliances for failure modes. As part of my responsibilities I have been directly responsible for multiple designs in appliances that prevent failures. Specifically, I have designed a water overflow protection system for

washing machines. Additionally, I have designed specific components for laundry-based products to eliminate the hazards associated with these products. I have been designated as an expert in approximately 10 cases involving the very defect at issue in this case. In addition, I have been designated as an expert in approximately 200 cases involving design defects in dryers, including many Electrolux dryers, which result in fires and other mechanical failures.

8. The concept of adequate hose length and adequate connectors is not unique to washing machines. This is a matter of mechanical and fluid dynamics. It applies to every situation where flexible hoses carry gases or liquids between two points, where the distance between the two points can change. This change in dimension places stresses upon the hose during the operation of the product. Flexible hoses that connect from part A to part B so as to allow the passage of liquid and/or gas exists in numerous machinery manufactured by a wide variety of industries, including the design componentry at issue. When an adequate hose length is used to cover the distance necessary, and adequate strain relief features are used, the hose does not suffer undue stress and does not fail prematurely. This design componentry at issue is applied in a myriad of circumstances including the automotive industry as well as other manufacturing industries. I have addressed this very design componentry not only in my work at the Wright Group in evaluating over 1000 washing machines, but also in my extensive work in auto engineering and design.

9. I have been personally involved at the Wright Group in testing over 200 washing machines that were made by this very defendant, Electrolux, and that resulted in failure (overflow) as a result of this specific defective design componentry at issue here. The various machines that come to the Wright Group for testing often are provided by insurance carriers, who have covered losses due to injuries and damages occasioned by machine overflow and who have entrusted the Wright Group to analyze and evaluate the design componentry that leads to overflow. I have been personally

involved in the inspection of at least a couple hundred washing machines manufactured by Electrolux that have failed, and caused overflow, as a result of the air hose disconnecting from either the air dome or pressure switch. I have been personally involved in the inspection of the following models: 417.92702200; 417.93702200; 417.94702300; 417.94872302; 417.98702891; 417.99802990; 417.99862990; CRWS5700AS0; FEX831CS0; FWS235RFS3; FWS445RFS0; FWS445RFS2; FWS445RFT2; FWS446GHS0; FWSB34RGS0; FWX223LBS5; FWX223LBS6; FWX223LBS8; FWX445RFS3; FWX6970EW4; GLWS1349AS1; GLWS1649AS; GLWS1649AS2; MWS445RES1; WSM2700AWW; WSM2700DAWWW; WSM2700WCWWW; WSM2780DBWWW; WSM2780DWW; and WWX433RFS0. In my observation of Electrolux washing machine failures, 90% of disconnections occur in the connection of the air hose to the air dome.

10. As the Court will see from the following, the design componentry criticized in this case by Plaintiff is extraordinarily simple. It involves simply extending the length of air hose that should exist between the pressure switch and the air dome and providing appropriate fixation for the air hose at the air dome and at the pressure switch, nothing more. This basic design componentry applies to each and every model Electrolux claims varies from each other and in each such model, the air hose extending from the air dome to the pressure switch is of inadequate length and the method for affixing the air hose to the air dome and to the pressure switch is inadequate due to inadequate fixation componentry. The models of machines Electrolux manufactures that contain this design componentry have a propensity to overflow. Attached as Exhibit A, purely for reference, are Electrolux illustrations of the air dome, the air hose, and the pressure switch that are the components of the claimed defective design. These three aspects of the design componentry at issue exist in each of the Electrolux models in question, despite Electrolux's protestations to the contrary.

11. The reason that the componentry in question is required is that it is necessary in the operation of all Electrolux models at issue to transfer a liquid and gas mixture from the air dome to the pressure switch. This is required to control the water level within the washing machine tub and liner. If the air hose disconnects from either the air dome or the pressure switch, a water overflow will occur. This is true because in such instances the water level pressure switch cannot monitor the water level within the washing machine.

12. As set forward in Plaintiff's Motion, the design features that comprise the defect as claimed by Plaintiff are as follows:

(a) There is an inadequate length of air hose that extends from the air dome to the pressure switch;

(b) Due to the inadequate length of air hose, identified in (a) above, under operating conditions the air hose disconnects from either or both the air dome and/or the pressure switch;

(c) The disconnection as identified in (b) above, causes overflow resulting in water extending beyond the washing machine and onto the surface of the floor outside the perimeter of the machine;

(d) In addition to the design defects identified in (a)-(c) above, Plaintiff claims the design defects also include an inadequate method of fixation of the air hose at the air dome end and an inadequate method of affixation at the pressure switch end. This improper affixation contributes to and encourages a disconnection of the air hose at the air dome end and at the pressure switch end, thus, compounding the defect of the inadequate air hose length discussed above;

(e) Based on the foregoing, and based on my experience, it is clear that a certain number of washing machines containing the defects identified in (a)-(d) above will fail before the expiration of useful expected life of the machine.

(f) The design componentry at issue claimed to be defective can easily be remedied by increasing the length of air hose utilized and affixing the increased air hose length at both the air dome end and the pressure switch end with the use of barbed connectors and clamps. And to be certain that the componentry is properly designed the barbed connectors and clamps should be used at both the air dome end and the pressure switch end.

(g) The term service loop as utilized in this declaration merely refers to the additional length of air hose Plaintiff believes the design componentry requires for the reason stated above so as to preclude disconnection for the reasons stated above during operation of the subject washing machines.

(h) The term adequate strain relief as utilized in this declaration merely refers to the concept that an adequate length of air hose between the pressure switch and the air dome properly secured as earlier described will relieve the strain on the air hose and its connections sufficient to preclude the disconnection of the air hose, which when disconnected causes overflow.

(i) The reason that the componentry in question is required is that it is necessary to transfer a liquid and gas mixture from the air dome to the pressure switch in the operation of all Electrolux models at issue for the reasons expressed in paragraph 11, above.

13. Thus, as will be pointed out below, the design componentry in question that Plaintiff claims is defective can be adequately remedied by an adequate length air hose that extends between the air dome and the pressure switch and that is appropriately affixed at the air dome connection and the pressure switch connection, which will thus provide adequate strain relief on the connection of the air hose during the operation of

the machine, precluding overflow. As will be pointed out below, in each and every one of the alleged different designs offered by Electrolux, each suffers the identical defect, namely, inadequate air hose length between the pressure switch and the air dome together with inadequate fixation of the air hose at the pressure switch and the air dome thus allowing for overflow during the machine operation due to ineffective and inadequate strain relief, i.e. there is too much strain on the hose and it disconnects because it is too short and isn't affixed to the air dome and to the pressure switch properly.

14. As Plaintiff's Motion accurately points out in each of the subject models there exists a common design where a piece of air hose of inadequate length inadequately connects the air dome to the pressure switch. If the air hose disconnects from the air dome during operation of the machine, the washing machine will overflow. The root cause of the design defect is the inadequate strain relief utilized to prevent disconnecting of the air hose from the air dome on the one end and from the pressure switch on the other end.

15. The various differences in componentry alleged by Electrolux in its Opposition are wholly immaterial and irrelevant to the design failure of the componentry in question. The design defect of an inadequate hose length and inadequate strain relief in the connections of the air hose between the pressure switch and the air dome will cause overflow regardless of the various design features referenced in Electrolux's Opposition. This design failure will exist as a threat to overflow in each and every model where it exists and the differences in other aspects of the machine as described by Defendant are irrelevant, immaterial and of no engineering significance as it relates to the design componentry at issue and claimed to be defective in Plaintiff's Motion.

16. For example, while it may be true that there are 23 different lengths of air hose, these differences in length are immaterial. This is true because each is inadequate

to cover the distance necessary and to incorporate a service loop in its connection to: the air dome on one end; and the pressure switch on the other end. All 23 lengths fail to adequately provide for clearance in the amount necessary to prevent overflow because they lack a service loop, i.e., they are simply too short.

17. The various changes and types of pressure switches utilized by Electrolux are irrelevant and immaterial to the alleged design defect because the changes in the pressure switches do not affect its connection to the air hose. As a hypothetical, even if one were to assume that the change in the pressure switch design that changes in various models did have some affect on the adequacy of the pressure switch connection, it would nevertheless remain the case that each model would still suffer from inadequate strain relief due to inadequate air hose length, and that each model would still suffer from inadequate strain relief due to inadequate fixation of the air hose to the air dome. Thus, the incidents of overflow wouldn't change. At best for Electrolux, these factors would merely encourage disconnection at the air dome to a larger extent than at the pressure switch connection.

18. I have reviewed the report submitted by Electrolux that was declared to be authored by Prof. Jahan Rasty, Ph.D., PE, MBA. The report considers variations that can lead to a disconnection of the air hose from the air dome and/or from the pressure switch. Despite the fact that there are a number of factors that can lead to disconnection, there is no dispute that if the air hose disconnects, the washing machines will overflow. The report illustrates the degrees of likelihood that a disconnection will occur. Prof. Rasty states in his report that various forces are created causing differences in stresses on the subject componentry during the operation cycle of various models. This is immaterial. What remains unaltered by his report is the fact that regardless of the forces created in the operating cycles of various models, the forces on the air hose is greater than the design componentry can accept because the hose is too short and inadequately affixed. This is true in each model referenced by Prof. Rasty.

19. The report does not identify a single machine or model of machine that contains a barbed connection of the air dome/the pressure switch to the air hose, and the utilization of a service loop secured by a clamp. The report does not identify a single machine or model of machine that contains a barbed connection of the pressure switch to the air hose, and the utilization of a service loop secured by a clamp. The only mention in the report of the utilization of any service loop and/or clamp is limited to the connection of the air hose to the pressure switch of stacked laundry centers that utilize a gas dryer. However, even in this limited selection of models, the design failure of the connection of the air hose to the air dome is consistent with all other machines and models described in the report. In other words, even in gas stacked laundry centers, the connection of the air hose to the air dome fails to contain a barbed connection of the air dome to the air hose, and fails to utilize a service loop secured by a clamp. At best for Electrolux, these factors would merely encourage disconnection at the air dome rather than at the pressure switch connection. This is true because the short hose inadequately affixed to the air dome will have a greater tendency to separate when the hose fails to possess adequate length and fails to be appropriately affixed.

20. The report concludes that utilization of a metal connection of the pressure switch versus a plastic connection of the pressure switch affects the amount of force necessary to disconnect the air hose from the pressure switch. However, these differences are irrelevant because both a metal connection and a plastic connection will allow for disconnection unless the connection is barbed and the air hose contains a service loop secured by a clamp.

21. The report describes the fact that pressure switches are more prone to wear and tear and become less accurate in measuring water levels as compared to electronic transducers. However, differences in ability to measure the water level are irrelevant to concluding that washing machines that utilize a pressure switch versus an electronic transducer contain a common design – inadequate air hose length and inadequate

fixation of the air hose – that can lead to disconnection and overflow. In other words, where there is a disconnection, the machine cannot measure the water level, regardless of whether the machine utilizes a pressure switch or electronic transducer.

22. The report concludes that the differences in design of the vibration absorption system affects how much force is needed to disconnect the air hose from the air dome and from the pressure switch and must be considered in connection with the motion producing components to determine adequate strain relief. Similar conclusions are offered with respect to the spin speed, the weight of the machines, and the duration of wash cycles. In other words, the report concludes that different spin speeds produce differing amounts of force, that lighter machines (i.e., free standing washing machines) produce more force, and that longer wash cycles produce more force on the connection of the air hose. These conclusions reinforce Plaintiff's allegation that a water level pressure system that utilizes an air dome, air hose and pressure switch are defective if the air hose is not of sufficient length and does not have adequate fixation that can lead to disconnection and overflow. And this same analysis defeats Electrolux's claim that laundry centers should somehow be analyzed differently.

23. The report discusses the inner diameter of the air hose in relation to the diameter of the connection to either the air dome or the pressure switch and concludes that there are differences in interference fit. However, the differences in interference fit are irrelevant to determining that any washing machine that utilizes an air dome, air hose, and pressure switch in its water level pressure system design will fail if the air hose is too short and the connections of the air hose to the air dome and/or pressure switch are not adequately secured.

24. The variations described in the report as to the application of the strain relief tape and the use of strain relief solvent support a conclusion that Electrolux's design for strain relief is inadequate because improper application of the tape and/or solvent compromises its intended strain relief. Moreover, for all of the reasons stated

above, these variations are irrelevant to the determination that washing machines utilizing an air dome, air hose, and pressure switch contain a common design that require an adequate hose length and adequate fixation of the hose to the air dome, tub liner, and to the pressure switch.

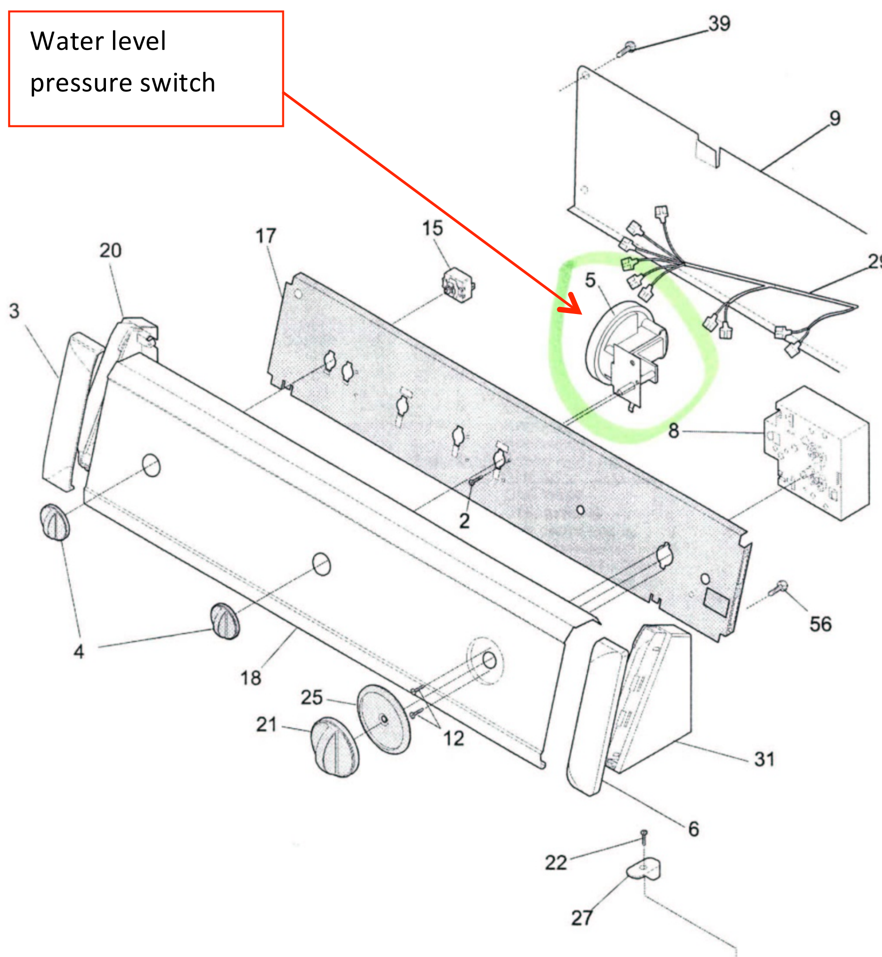
25. Finally, the report describes the differences in resulting forces produced by incorrect installation and service of the machine. Again, these are irrelevant in the determination of the existence of a common design of the water level pressure system.

26. In order to adequately address the defective design componentry, there would be a cost for each machine. That cost would include the cost of parts that I approximate to be less than $10.00. That cost would also include the cost of labor that I would estimate to be $50-$100 at the site of the repair. At the site of manufacture, I estimate the cost of repair is significantly less.

I declare under penalty of perjury under the laws of the State of California and the laws of the United States that the foregoing is true and correct.

Executed this 11 th day of June 2014, at Uxbridge (*city*), MA (*state*).

By: [signature]
Ronald L. Parsons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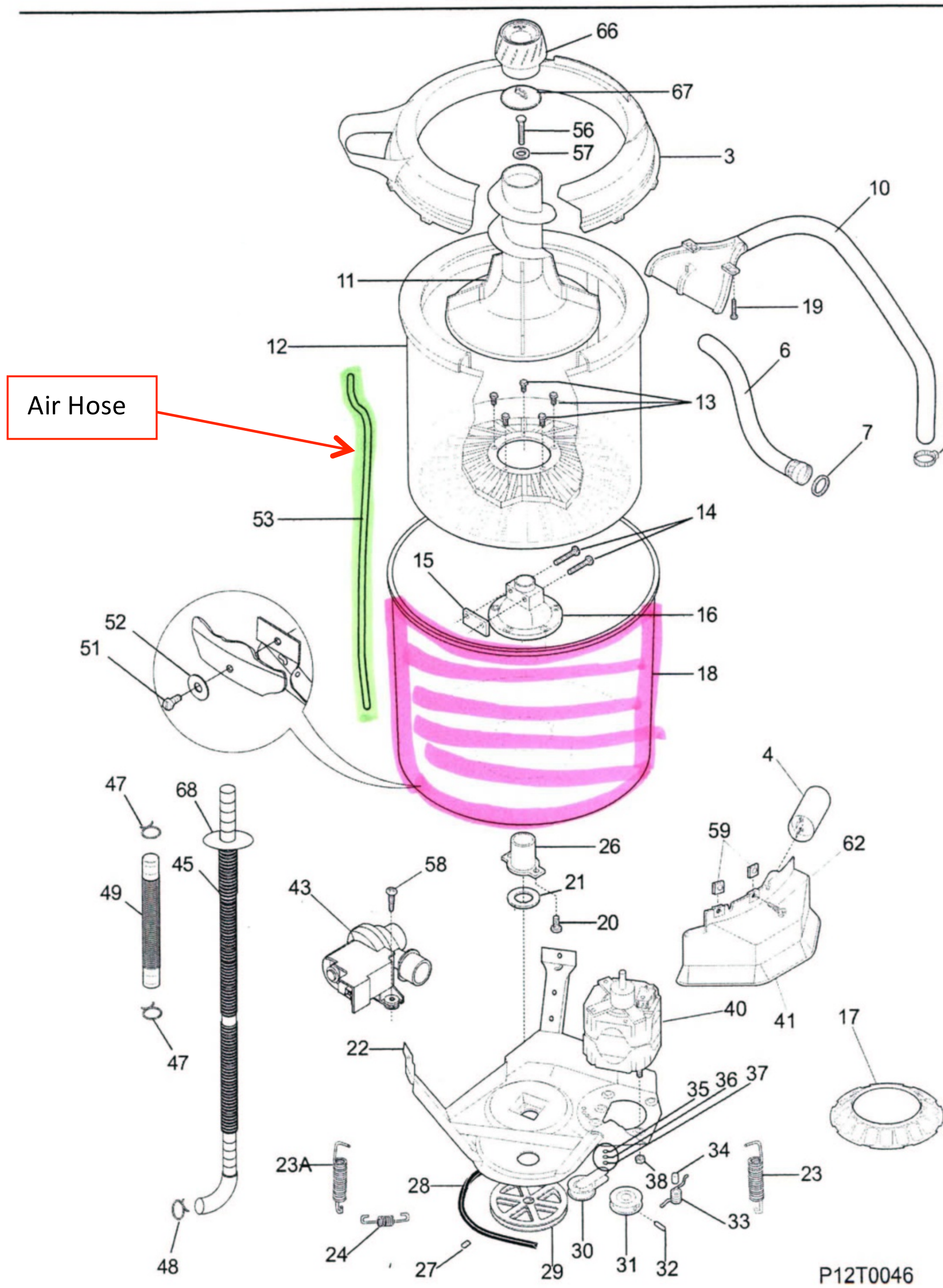
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