BRIEFING PACKAGE:

Staff Briefing Package on Furniture Tipover

September 30, 2016

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Table of Contents

Introduction 1

Background 2

Market conformance 3

Effectiveness of current standards 5

Conclusions 7

Tab A 9

LSM Staff Memorandum, ... 9

"Furniture Tip-over Testing" 9

Tab B 21

ESHF Staff Memorandum, ... 21

"ASTM F2057 – 14 warning labeling requirements: market compliance and voluntary standard evaluation" 21

Tab C 34

LSM Staff Memorandum, ... 34

"Value and limitations of ASTM F3096-14 Standard Performance Specification for Tipover Restraint(s) Used with Clothing Storage Unit(s)" 34

Tab D 39

ESHF Staff Memorandum, ... 39

"Human Factors Assessment of Furniture Tipover Incidents" 39

Tab E 50

Human Factors Staff Estimate of Weight in Support of Furniture Tipover Activities 50

Tab F 53

LSM Testing protocol for Clothing Storage Units 53

UNITED STATES
CONSUMER PRODUCT SAFETY COMMISSION
ROCKVILLE, MD 20850

This document has been electronically approved and signed.

MEMORANDUM

DATE: September 30, 2016

TO: The Commission

Todd A. Stevenson, Secretary

THROUGH: Mary T. Boyle, General Counsel
Patricia H. Adkins, Executive Director
DeWane Ray, Deputy Executive Director for Safety Operations

FROM: George A. Borlase, Ph.D., P.E., Assistant Executive Director,
Office of Hazard Identification and Reduction

John Massale, P.E., Mechanical Engineer
Division of Mechanical Engineering, Directorate for Laboratory Sciences

SUBJECT: Staff Briefing Package on Furniture Tipover

INTRODUCTION

The U.S. Consumer Product Safety Commission (CPSC or Commission) has jurisdiction over clothing storage units (CSU) produced or distributed for consumers. The subject products are typically identified as dressers, armoires, chests of drawers, and wardrobes. CPSC staff has completed an assessment of the general state of CSU safety, in accordance with the CPSC Fiscal Year 2016 Operating Plan. The Commission requested that staff investigate the validity and efficacy of the two voluntary standards, ASTM F2057-14 *Standard Safety Specification for Clothing Storage Units* and ASTM F3096-14, *Standard Performance Specification for Tipover Restraint(s) Used with Clothing Storage Unit*. Specifically, the Commission directed staff to draft a briefing package to address:

- Current market levels of compliance with ASTM F2057-14, including an approximation, based on available information, of the market share of each of the furniture models found not to be in compliance;
- ASTM F2057-14's effectiveness when considering foreseeable misuse; and
- Whether ASTM F3096-14 limits the use of more easily installed anchoring systems and potential alternative solutions.

In response to this direction, staff developed a plan to conduct an analysis of the market to determine the rate of compliance and then used the knowledge gained to examine the shortcomings and merits of the two standards (ASTM F2057-14 and ASTM F3096-14).

BACKGROUND

EXISTING STANDARDS

ASTM F2057-14 is intended to reduce injuries and deaths of children from hazards associated with tipover, and is intended to cover children up to and including age 5. The standard covers CSUs, including combination chests, door chests, and dressers over 30 inches in height, that are freestanding. Other furniture, such as dining room furniture, bookcases, and armoires are not covered by the standard. F2057-14 has performance requirements for stability of the CSU, requirements for the inclusion of tipover restraints, and requirements for a warning label.

STABILITY

ASTM F2057-14 sets forth two main stability requirements:

- the empty unit shall not tip over when all of the drawers are open to their full extension
- the empty unit shall not tip over when a 50 lb weight is hung from each open drawer at full extension, with only one drawer open at a time.

The 2014 publication of the standard modified previous requirements, which called for testing when the drawers were opened two-thirds of their operational sliding length. Operational sliding length is measured from the inside back of the drawer to the inside face of the drawer front in its fully closed position.

TIP RESTRAINT DEVICES

In 2009, ASTM F2057 included new requirements to address a need for tip restraint devices (TRD). The tip restraint provisions were intended to be additional requirements, separate from the freestanding stability requirements. The provisions did not specify the style or design of the TRDs. The only performance requirement was that the TRD "withstands a pull force of 50 lb." However, no test protocols accompanied this metric.

In 2014, the TRD requirements were moved into a separate standard, ASTM F3096-14. This updated standard contained a testing protocol. Staff provides a review of ASTM F3096-14 in Tab C.

LABELING

The labeling requirements in ASTM F2057 have varied slightly over the years, but the formatting requirements in ASTM F2057-14 are generally consistent with warning formatting requirements contained in ANSI Z535.04-2011, *American National Standard for Product Safety Signs and Labels.* Human Factors staff's analysis of the current labeling requirements in ASTM F2057-14 is found in Tab B.

MARKET CONFORMANCE

ESTIMATING THE SIZE OF THE MARKET

Based on Bureau of Labor Statistics data, about 17,700 firms in the United States are involved in furniture manufacturing, importation, and/or distribution.[1] Describing the exact market share of each CSU model/design produced by each firm is very difficult. Furniture can be purchased through various distribution channels, including home furnishing stores, big box retailers, furniture specialty stores, and online retailers. Although market research reports are available for purchase, these reports contain broad information and do not provide specific information of unit sales by product design, make, or model. Firms may own multiple brands or license their brands as well. Data on sales by product type are rarely publicly available. Other measures of firm size, such as gross sales or number of employees, are usually only available for publicly traded firms. Retailers may also carry other furniture products, like beds or tables, which could cloud the results.

MARKET SURVEY BASIS

Staff estimates it would take several years and several million dollars' worth of samples to produce a statistically sound representation of the CSU market because of the large diversity of models and features.

To construct a sample group of CSUs for testing, staff began with a list of 531 CSUs, representing 102 manufacturers/importers. Field Operations staff developed the sample based on retail and internet site inspections. The initial convenience sample[2] of 531 CSUs includes a variety of options available to American consumers based on cost, size, and number of drawers.

Laboratory Science (LS) staff organized this convenience sample of 531 CSUs, according to the number of drawers present in the CSU.

LS staff then applied a screening approach using three variations of the same estimated tipover force formula with the goal of selecting about 60 units to evaluate for physical collection and testing. Staff chose 60 units as the target number due to constraints on resources and timing, but staff ultimately collected and tested 61 samples.

Staff designed the screening formula to estimate how much force is needed on an open drawer to incite a tipover. The formula is an application of a moment analysis on a free body diagram. The formula uses weight, depth, and an assumed location for the CSU's center of gravity (CG), to yield an estimated tipover force. The CG location had to be assumed because staff did not have physical samples of the 531 units, and therefore, could not measure the CG. Additionally, staff assumed CG because different models use different materials and weight distributions. Tab A contains a visual aid for the CG assumptions.

[1] http://www.bls.gov/iag/tgs/iag337.htm.
[2] A convenience sample is a non-probability sample whereby samples are selected by availability or similar criteria

Staff plugged the advertised dimension and weight information for each of the 531 CSUs into the estimated tip formula, but used three different assumed CG locations to yield three different estimated tip forces. The assumed CG locations were of 50 percent, 42.5 percent, and 35 percent of depth, referenced from the front of the CSU. The estimated tip formula, with an assumed CG location of 50 percent, is shown below.

$$\frac{(\boldsymbol{Weight}*(\boldsymbol{Depth}\times\mathbf{50}\%))}{(\boldsymbol{Depth}-\mathbf{4}")} = \boldsymbol{Estimated\ Tip\ Force}$$

Each of the 531 CSUs was then placed into one of four categories, according to the respective CSU's three estimated tip forces:

- probable pass: the estimated tip force was greater than 50 lb, if CG was assumed to be 35%;
- potential pass: the estimated tip force was less than 50 lb, if the CG was assumed to be 35%, and the estimated tip force was greater than 50 lb if CG was assumed to be 42.5%;
- potential failure: the estimated tip force was less than 50 lb if CG was assumed to be 42.5%, and the estimated tip force was greater than 50 lb if CG was assumed to be 50%;
- probable failure: the estimated tip force was less than 50 lb, if the CG was assumed to be 50%.

Note that there are four categories listed, but physical testing of samples later produced only two categories: "pass" and "fail." The binary distinction is only relevant to compliance with ASTM F2057-14, which will be examined later. Four categories were necessary to examine which CG location assumption in the estimated tip force formula would most closely predict the binary results of ASTM F2057-14 stability conformance.

Staff collected two to four specific CSUs from each of the four stability classifications with respect to different numbers of drawers, resulting in a total of 61 CSUs to be tested. A more complete description of the selection process is outlined in Tab B.

TESTING OF SAMPLES

Field Operations staff purchased, and EXHR staff tested, the 61 selected CSUs to determine conformance with the ASTM F2057-14 voluntary standard's requirements for stability, labeling, and TRDs. Slightly more than half (31/61) of the CSUs failed stability testing, 91 percent (56/61) failed to meet all the labeling requirements, and 43 percent (26/61) failed the tip restraint device requirements by either not being able to withstand a 50 lb pull force (8/61) or not including a TRD with the CSU at all (18/61).

The weight of the CSU was the factor that had the highest correlation to the CSU passing the ASTM F2057-14 stability requirement. Specifically, heavier CSUs had a higher likelihood of passing. This is described in detail in Tab A.

Staff collected a sample group where half were predicted by the estimated tip formula to fail ASTM F2057-14 stability requirements. Because about half of the samples did fail, and 42.5

percent was used as the delineation between "possible pass" and "possible fail," the results of physical testing validate the general accuracy of the CG assumption. As presented further in Tab A, the 42.5 percent CG assumption proved to be the version of the estimated tip formula that was closest to the actual stability testing results.

Staff also performed overload testing beyond the requirements of ASTM F2057-14 to determine the weight margin or lack of margin to tipover from the 50-lb test requirement. In this series of tests, the 50-lb test weight was replaced with a force gauge to measure the failure point. Several of the drawer glides could not withstand force values over 60 lb, and they broke before the furniture tipped. The full results are listed in an Appendix to Tab A.

The testing protocol used by staff is appended as Tab F. It was developed by LS staff as stand-alone document that adds overburden testing (i.e., progressive testing to see at what weight the CSU tipped) and CG determination to the tests of ASTM F2057-14. It was originally developed for this briefing package but will continue to be used to collect data for further investigations to further refine the estimated tip force formula.

EFFECTIVENESS OF CURRENT STANDARDS

DEFINING THE HAZARD PATTERN

The review of fatal incident data discussed in Tab D indicates that it is foreseeable and developmentally expected for children younger than 6 years of age to interact with CSUs to dress themselves, place and remove items on top of the CSU, and exercise developing problem-solving skills by stepping on lower drawers in order to reach items in upper drawers and on top of a dresser. In addition, although clothing storage furniture is not intended to support climbing, it is also developmentally expected for children to use furniture for pretend play. In addition, the 95th percentile weight of 5-year-old children is likely to be about 60 pounds (27.2 kg) or greater. See Tab E for more information. Thus, it is reasonable to consider the following scenarios when evaluating the effectiveness of the voluntary standard:

- a child under age 6 and weighing up to 60 lb climbing on a clothing storage unit to play;
- a child under age 6 and weighing up to 60 lb standing on a lower drawer in order to reach into an upper drawer; and
- a consumer of any age simultaneously opening multiple drawers that contain items typically stored in a dresser.

LABELING

The content and format of the warning label is specified in ASTM F2057 - 14, section 4.6. Of the 61 CSUs available for evaluation, 34 (56%) contained a warning label related to tipover hazards. However, the tipover warning labels varied greatly among units. In addition, although ASTM F2057 – 14 required the labels to be placed "in a conspicuous location," there was considerable variation in label location among the 61 CSUs. Although some standards (*e.g.*, many of the durable nursery product standards) address placement by defining "conspicuous" in a manner

that describes when the warning must be visible to the consumer, ASTM F2057-14 does not define conspicuous. Engineering Sciences, Human Factors, (ESHF) staff found significant opportunities, described in Tab B, to improve warning effectiveness by revising the requirement contained in the voluntary standard. Specifically, staff makes the following labeling recommendations, which will be refined in coordination with ASTM to provide the specificity needed:

- strengthening requirements for permanency;
- identifying a conspicuous location on clothing storage units for the warning label;
- allowing better customization of hazard-avoidance statements based on unit design, *i.e.,* allowing manufacturers to select the content of the hazard communication messages that are applicable to each model;
- comparing warning messages with incident data to make sure that the known hazardous situations are identified; and
- Revising the message panel text in a manner that is understandable and does not contradict typical clothing storage unit use and in ways that motivates consumers to comply with the warning.

MARKET SAMPLE STABILITY ASSESSMENT

As noted above, staff decided to use the sample collection as a way to hone the predictive capability of the estimated tip formula. Therefore, the bias in the physical collection criteria precludes the extrapolation of the staff's stability test data to represent the entire market.

There were 102 distinct manufacturers/importers in the initial 531 CSUs screened by field staff. There were 48 distinct manufacturers/importers represented in the 61 test units. There were 25 distinct manufacturers/importers represented in the 31 CSUs that failed ASTM F2057-14 stability requirements.

Using the estimated tip force formula, assuming a CG location of 42.5 percent of CSU depth, staff can predict that 118 of the 531 samples (22%) would likely fail ASTM 2057-14 stability testing. There are 51 manufacturers/importers represented in the 118 CSUs predicted to fail ASTM 2057-14 stability testing.

TIP RESTRAINT DEVICES

ASTM F3096-14 is a very limited standard with one test that can only address one style of TRD. Staff notes several other limitations, such as a lack of explicit failure criteria, inappropriate force application, inappropriate test duration, and conflicting protocol instructions. The limitations are further delineated in Tab C.

The examination of the 61 samples revealed that 18/61 CSUs (30%) did not include TRDs. All of the TRDs that were included were strap-style. Staff believes that consumers will not always

install TRDs. This conclusion is supported by a few incident reports, referenced in Tab D, that specifically mentioned a restraint was not attached. Additionally, staff has proposed alternative anchoring systems to the industry to spur innovation.[3] Staff believes that F3096 could be improved to incorporate innovative designs that may eventually withstand proposed increased test weight of 60 lb.

These innovative designs warrants revisiting the original intention that TRDs should be additional to the freestanding stability requirements. Integrating performance requirements of an overburdened test with a functionality test of a TRD (i.e., the system test described in Tab C) could serve as a way to address worst-case hazard scenarios without overly constraining designs. For example, a manufacturer may not need to withstand a 60 lb test weight if it can otherwise fully address the worst case scenario hazard pattern.

CONCLUSIONS

Staff's testing indicates that 31 out of 61 CSUs samples do not comply with stability requirements ASTM F2057-14. These results were used to validate the estimated tip formula. Staff predicts 118 CSUs (22%), of the 531 CSUs identified in the convenience sample would likely fail ASTM 2057-14 stability testing. This represents 51 of the 102 manufacturers in the sample. Additionally, the majority of labels from 61 samples tested show lack of conformance to label content or even the existence of a tipover-related label. Finally, 26 out of 61 samples failed the TRD requirements.

Based on the 2,600 estimated emergency department-treated injuries involving only chests, bureaus, or dressers falling on children and the 97 furniture tip-over-related fatalities to children from 2000 to 2015,[4] staff believes that more work needs to be done to effectively address the risk of tip-over incidents.

Staff will continue to build a larger sample size of data to refine the estimated tip formula, and will provide more robust analysis of furniture stability characteristics.

Staff will continue to actively engage with the ASTM subcommittee to develop an effective standard, as follows:

- increase the test weight from 50 lb to 60 lb to represent 95th percentile of children up to age 6, and to address the effect of alternate flooring materials, such as carpeting on tipover;
- reintegrate tip restraint performance requirements into ASTM 2057-14;

[3] https://www.cpsc.gov//PageFiles/182505/TipoverPreventionProjectAnchorswithoutTools.pdf.

[4] *Product Instability or Tip-Over Injuries and Fatalities Associated with Televisions, Furniture, and Appliances: 2016 Report.* Suchy Adam. August, 2016.

- develop system-level testing methods that allow for the innovation of alternate or integrated TRDs; and
- modify the warning label to address the deficiencies staff has noted

As part of this planned ongoing voluntary standard effort in FY 2017, EXHR staff will continue to work with stakeholders to improve ASTM F2057-14.

Additionally, staff identified issues with ASTM F3096-14, finding that the existing standard does impede potential alternative solutions, as described in Tab C. Staff will continue to work with the subcommittee to expand this standard.

Finally, staff has proposed in the FY 2017 Operating Plan an advance notice of proposed rulemaking to address the hazards associated with tipover of freestanding clothing storage units.

TAB A

LSM STAFF MEMORANDUM,

"FURNITURE TIP-OVER TESTING"

UNITED STATES
CONSUMER PRODUCT SAFETY COMMISSION
ROCKVILLE, MD 20850

MEMORANDUM

September 30, 2016

TO : John Massale, P.E., Mechanical Engineer, Furniture Tipover Project Manager
Division of Mechanical Engineering, Directorate for Laboratory Sciences

THROUGH: Andrew Stadnik, P.E.,
Associate Executive Director for Laboratory Sciences

Michael Nelson
Director, Division of Mechanical Engineering

FROM : Michael Taylor, MSPM, Mechanical Engineer
Division of Mechanical Engineering, Directorate for Laboratory Sciences,

SUBJECT : Furniture Tipover

INTRODUCTION

The ASTM International (ASTM) voluntary standard ASTM F2057–14, *Standard Safety Specification Clothing Storage Units*, establishes requirements for freestanding clothing storage units (CSU), such as dressers, chests, and armoires , in the United States. The standard is intended to minimize the hazards associated with tipover incidents. ASTM developed this voluntary standard in response to incident data supplied by staff of the U.S. Consumer Product Safety Commission (CPSC or Commission). The current, published version of the voluntary standard is ASTM F2057–14. Part of ASTM F2057–14 references ASTM F3096–14 S*tandard Performance Specification for Tipover Restraint(s) Used with Clothing Storage Unit(s).* In the Fiscal Year 2016 Operating Plan, the Commission directed staff to prepare a briefing package related to furniture tipover to address:

- Current market levels of compliance with ASTM F2057–14, including an approximation, based on available information, of the market share of each of the models found not to be in compliance;
- ASTM F2057–14's effectiveness when considering foreseeable misuse; and
- Whether ASTM F3096–14 limits the use of more easily installed anchoring systems and potential alternative solutions.

This memorandum focuses on product testing performed by staff to assess current market levels of compliance with ASTM F2057–14, specifically stability requirements of the product.

SAMPLE COLLECTION

Field staff performed an online review of furniture retailers and manufacturers and identified 531 CSUs from 102 manufacturers. Staff recorded the dimensional information, including length, width, height, depth and weight, as a starting point to select units to purchase and to conduct product testing. Staff filtered the list of products based on available dimensional product information, which included the number of rows of drawers.[1] There were 340 samples remaining with all the data, and they were separated into six groups, based on the number of rows of drawers. This categorization allowed staff to purchase a variety of samples for each type of dresser:

- Fewer than three rows of drawers;
- Three rows of drawers;
- Four rows of drawers;
- Five rows of drawers;
- Six rows of drawers; and,
- More than six rows of drawers.

A screening formula was then developed that staff hypothesized would estimate whether a unit would pass the current ASTM F2057–14 standard test by estimating the tip force required for each unit based on the product dimensions. The formula below represents a relationship of dimensional design and center of gravity (CG), which uses weight and depth of the product to estimate the tip-over force as illustrated in Figure 1, which shows moments about the front of the CSU (where "Depth" is 0%), with CSU weight acting counter clockwise and tip force clockwise:

$$\frac{(\boldsymbol{Weight}*(\boldsymbol{Depth}*\mathbf{50\%}))}{(\boldsymbol{Depth}-\mathbf{4"})} = \boldsymbol{Estimated\ Tip\ Force}$$

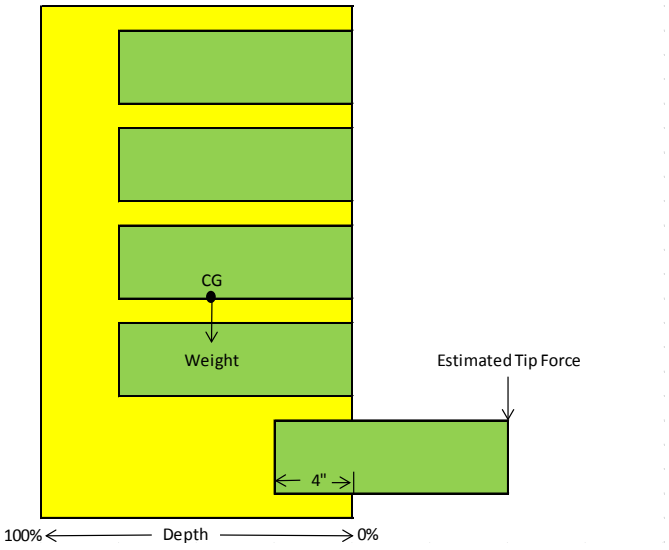

Figure 1

[1] Staff obtained information from manufacturers' and retailers' websites.

The formula contains assumptions about estimated CG in the numerator (Depth*50%) and the denominator (Depth minus 4"). Specifically, the formula uses a conservative estimate about the CG. The formula assumes a uniform CG in the two-dimensional center of the dresser. The formula was then repeated two additional times to provide subgroups of samples while estimating the CG closer to the front of the unit (42.5% and 35% from the front edge). This represents common design features, such as heavier material used for drawer fronts and also drawer pulls. The calculation in the denominator (Depth minus 4) assumes a full drawer extension based on an industry practice that, on average, 4 inches of drawer does not extend past the front edge of the dresser. The table below shows the estimated failures, using dimensional data recorded from the manufacturer/retailer website.

Each of the 531 CSUs was then placed into one of four categories according to the respective CSU's three estimated tip forces.

- "probable pass" – the estimated tip force was greater than 50 lb, if the CG was assumed to be 35%;
- "potential pass" – the estimated tip force was less than 50 lb if the CG was assumed to be 35%, and the estimated tip force was greater than 50 lb if CG was assumed to be 42.5%;
- "potential failure" – the estimated tip force was less than 50 lb if the CG was assumed to be 42.5%, and the estimated tip force was greater than 50 lb, if the CG was assumed to be 50%; and
- "probable failure" – the estimated tip force was less than 50 lb, if the CG was assumed to be 50%.

Applying the three different CG estimates resulted in four subgroups of samples within each number-of-rows-of-drawers group. Samples were then selected from each subgroup to create a spanning set across dresser types. A statistical sample was not pursued because the number of dressers required would have gone beyond available fiscal and human capital resources. A breakdown of the delineation of the 340 CSUs into the four categories is shown below in Table 1.

Table 1: Subgroup delineation of field staff online review

	Probable Pass	Potential Pass	Potential Failure	Probable Failure
<3 rows of drawers	1	3	0	4
3 rows of drawers	33	22	15	26
4 rows of drawers	20	13	14	20
5 rows of drawers	30	13	21	5
6 rows of drawers	48	13	4	7
>6 rows of drawers	24	3	0	1

The number of samples collected for physical testing, from each CSU category, was chosen to maintain association with the same number of CSUs from each category in the 531 CSU survey. These samples were selected from each of the four categories shown above. This resulted in a sample size of 61 units from 46 different manufacturers.

Table 2: Predicted Failures Prior to Testing

	Estimated Tip Force Calculation		
CG values	50%	42.50%	35%
Sampling predicted Failures of the 61 CSU samples	22	31	54

TEST PROCEDURE

There are two voluntary standards that cover clothing storage units, ASTM F2057–14 *Standard Safety Specification for Clothing Storage Units* and ASTM F3096–14 *Standard Performance Specification for Tipover Restraint(s) Used for Clothing Storage Unit(s)*. Section 4.1 of ASTM F2057–14 outlines the performance requirements of the CSU while it is empty and the tip restraint device is not installed. The first test, described in section 7.1, requires that all drawers be extended to their outstop or in the absence of such feature, to 2/3 of their operational sliding length. The second test, described in 7.2, requires the user to open each drawer to the outstop or in the absence of such feature, to 2/3 of their operational sliding length and test each drawer with the 50-pound test fixture on top of the drawer front. Sections 4.4 and 4.5 refer to the tip restraint device being included with the CSU and tested to ASTM F3096–14. The tip restraint test in ASTM F3096–14 section 4 requires the user to secure one end of it to a structure and apply 50 lbf at the fastener of the other end for period of 30 seconds. This test is not representative of a real world scenario and fails to simulate the hazard pattern because the test does not take into account the system of the dresser, tip restraint, force of a tip event and wall.

CPSC staff conducted additional testing beyond that required in the standard to determine the force required to tip over the CSU in both test scenarios by applying a downward force on the fully extended drawer front. The tip forces were recorded for additional testing with all drawers open: 25 CSUs tip over with less than 20 lbf applied to the top drawer front, one unit was not recorded because the top drawer broke, and the remaining 35 CSUs required over 20 lbf to incite a tip. Of the 30 CSUs that passed the test procedure in Section 7.2, actual tip forces were recorded as additional testing in which the 50-lb fixture and additional force was applied to the top drawer; 22 CSUs tip with less than 10 lbf, six CSUs required less than 26 lbf and two units drawers broke. Staff also examined CSU dimensions, weight, CG and drawer extension for any association with pass/failure of testing. The data were collected in an effort to link design specifications to stability of each unit in order to provide guidance for manufacturers to ensure compliance with the stability requirements of ASTM F2057–14 *Standard Safety Specification for Free standing Clothing Storage Units.* All testing was performed on hard, level, flat surface. Staff considered using carpet, but decided carpet would be difficult to build into a repeatable testing protocol due to material inconsistencies and other factors associated with carpet installation and the variety of carpet types used in homes.

PRODUCT TEST RESULTS

Test results show:

- 31/61 CSUs failed to meet all of the performance requirements stated in ASTM F2057–14 section 4.1, specifically the stability test in which the 50-lb test fixture is placed on each drawer front
- 8 CSUs failed the tip restraint requirement of ASTM F3096–14 section 4
- 18 CSUs did not include a tip restraint with their product
- 11 CSUs passed both stability and tip restraint requirements in the ASTM standards.

Appendix A provides detailed results of the product testing. The drawers for two CSUs broke during testing with the 50 lb test fixture and testing could not be completed. Table 3 below shows a summary of test results for each type of CSU tested.

Table 3: Results of Stability Testing

Category	Number Passed	Number Failed
Less than 3 rows of drawers	1	3
3 rows of drawers	7	5
4 rows of drawers	5	7
5 rows of drawers	4	9
6 rows of drawers	3	3
more than 6 rows of drawers	3	1
6 drawer double wide (2x3)	7	3
Total	30	31

In addition, the estimated tip force calculation with a CG of 42.5 % best represents actual test results. Each sample was analyzed with the estimated tip force calculation a second time utilizing actual product dimensions recorded and after testing revealed which units actually failed. The differences noted from pre-test estimations are a result of incorrect product dimensions posted on retailers' websites. Post-testing results are shown below in table 4.

Table 4: CG validation for Estimated Tip Force Calculation

	Estimated Tip Force Calculation		
CG values	50%	42.50%	35%
Predicted Failures (reported dimensions)	22	31	54
Predicted Failures (actual dimensions)	19	32	55
Predicted Failures that passed	3	7	25
Predicted Passes that failed	15	6	1
Actual # of Failures predicted	16	25	30
Failure indication rate	52%	81%	97%
Missed Failure indication	10%	23%	81%

The estimated tip force calculation with a CG of 42.5% was the most effective failure indicator for this sample lot. It predicted the most actual failures and least missed failures. The estimated tip force calculation predicted actual failures with an eighty-one percent accuracy rate and a missed rate of twenty-three percent based on this sample lot. These results are based only on the 61 samples tested, and it is probable that the CG estimate will change as we test more CSUs in the future. This work provides one screening tool that can help predict if a CSU will tip with less than 50 lbf. Using the estimated tip force formula, assuming a CG location of 42.5% of CSU depth, staff can now predict that 118 of the 531samples (22%), which consist of 51 manufacturers, would likely fail ASTM F2057–14 stability testing. Figures 2 to 6 display the test results for products with three, four, five, six rows of drawers, and six drawer double wide (2 column by 3 row) CSUs respectively. Test results reveal a relationship between the estimated tip force and weight of the CSU: in general, the greater the weight of the dresser, the more force is required to tip the product over. The CSUs that passed stability testing are shown in green while failures are shown in red.

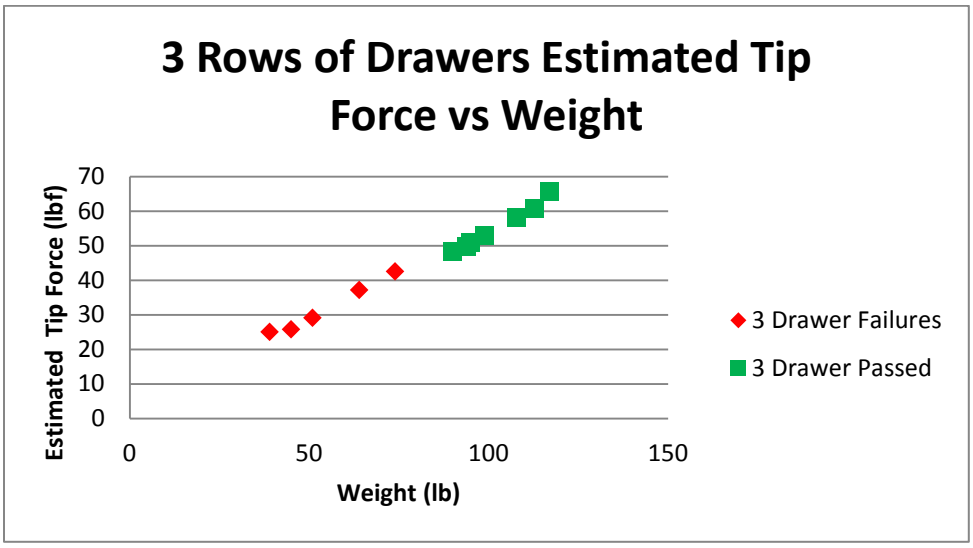

Figure 2: Three rows of drawers test results

The results of the three rows of drawers test samples tested revealed 8 CSUs over 74 lb passed ASTM F2057–14 section 4.1.

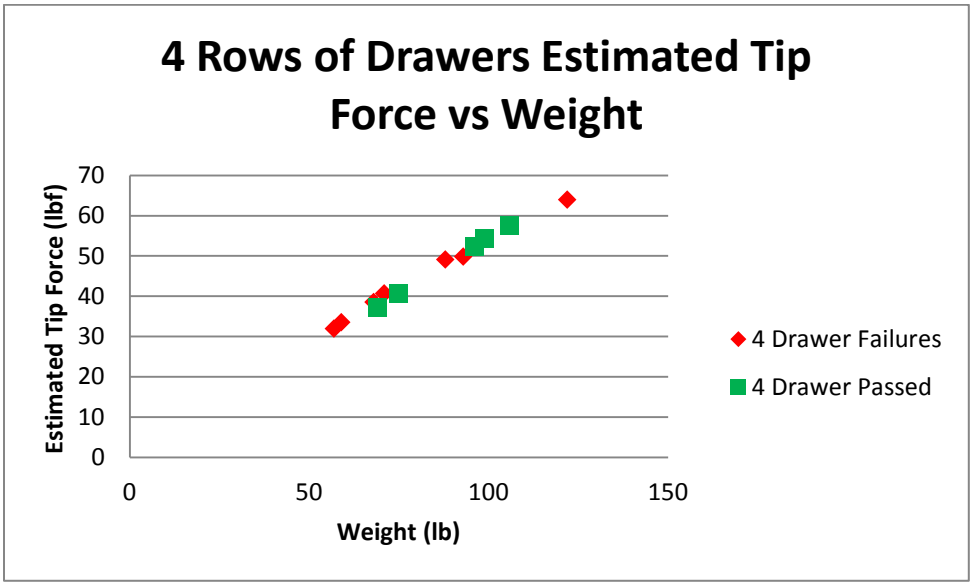

Figure 3: Four rows of drawers test results

The results of the four rows of drawers samples tested revealed 3 units over 93 lb passed the ASTM F2057–14 section 4.1. Three outliers are noted in testing, two units weighed less than 75 lb and passed, while another weighed 122 lb and failed testing.

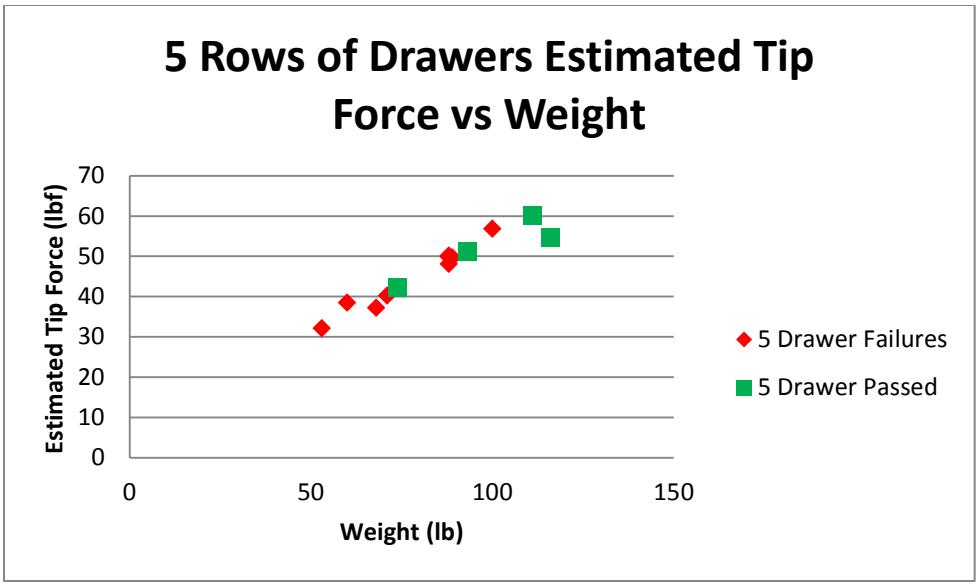

Figure 4: Five rows of drawers test results

The results of the five rows of drawers samples tested revealed 3 CSUs over 88 lb passed ASTM F2057–14 section 4.1. Two outliers were noted in testing, one CSU weighed 100 lb and failed testing, while another weighed 74 lb and passed.

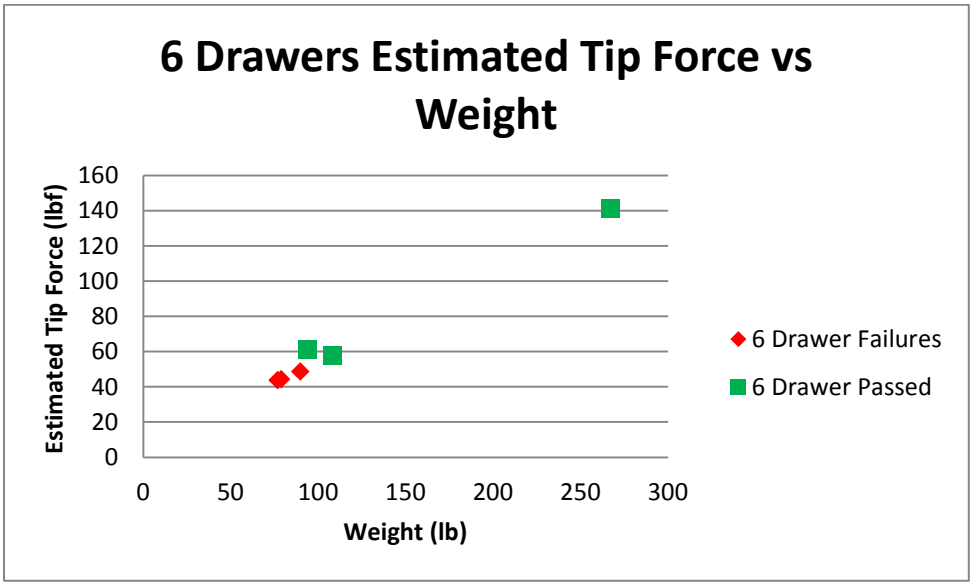

Figure 5: Six rows of drawers test results

The results of the six rows of drawers samples tested revealed 3 CSUs over 90 lb passed ASTM F2057–14 section 4.1. Although testing these six CSUs shows no overlap of passed and failed samples, more samples are required to draw any further conclusions.

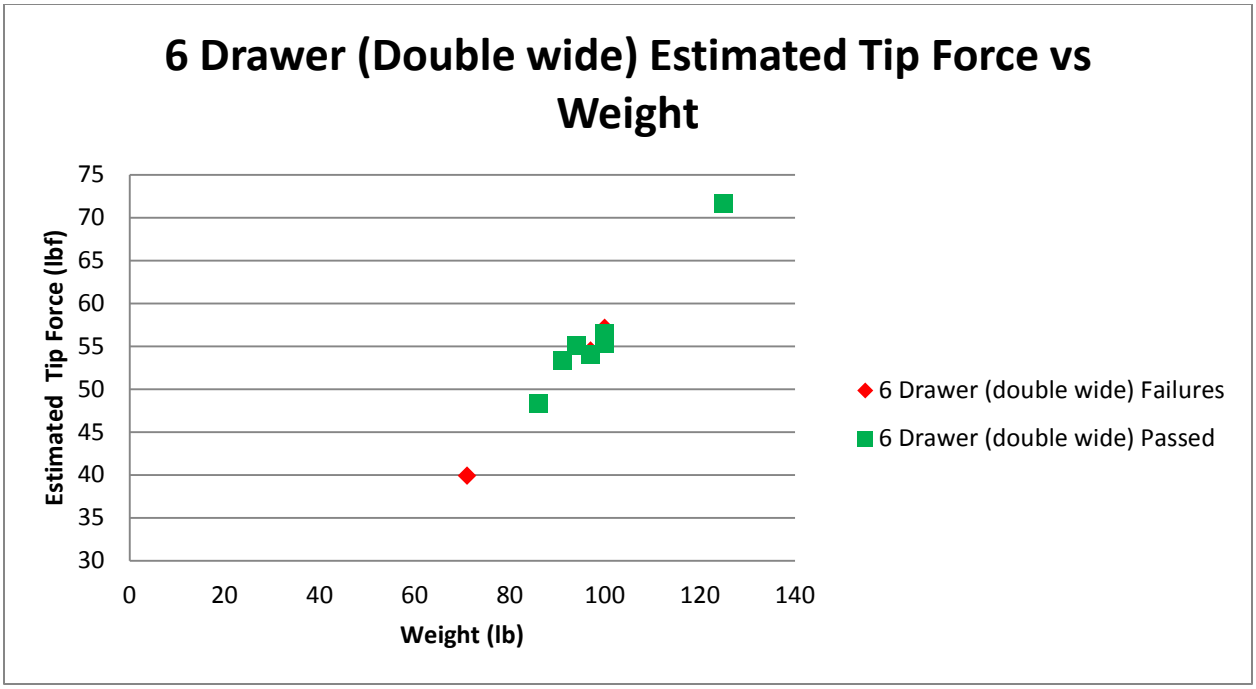

Figure 6: Six drawer double wide test results

The results of the six drawer double wide samples were filtered due to the popular industry design and dimensional difference from the traditional three single-drawer CSU. Testing revealed significant overlap between passed and failed units. The relationship between weight and estimated tip force is not clear based on our testing of 10 CSUs; a larger sample size may remedy this.

CONCLUSION

Staff tested 61 samples based on the voluntary standards and found that 31 of 61 samples are not in compliance with the stability requirements of ASTM F2057–14 *Standard Safety Specification for Free standing Clothing Storage Units.* Staff found18 of 61 samples did not include a tip restraint device with their product. These 61 samples represent 46 manufacturers of clothing storage units. The estimated tip force calculation is useful in identifying potential CSUs that require less than 50 lbf to incite a tipover. Future testing will help refine the estimated tip force calculation as our sample size will increase and our CG estimate may be refined. Based on this convenience sample, it appears CSUs from at least 25 manufacturers are not in compliance with the voluntary standards for CSUs.

References

ASTM F2057-14 Standard Safety Specification for Clothing Storage Units. Copyright © ASTM International Barr Harbor Dr., P.O. Box C-700 West Conshohocken, PA 19428, USA Published 2014.

ASTM F3096-14 Standard Performance Specification for Tipover Restraints Used for Clothing Storage Units. Copyright © ASTM International Barr Harbor Dr., P.O. Box C-700 West Conshohocken, PA 19428, USA Published 2014.

Appendix A

Sample	Rows of drawers	Height	Width	Depth	Weight	7.1 All drawers out	7.2 One drawer 50lb	7.1 configuration - value is force (lbs) to casue tipover	7.2 configuration - least distance the drawer open which fails 7.2	7.2 Configuraiton - value is force (lbs) to cause tipover	Contain Tip restraint	Actual Height	Actual Width	Actual Depth	Actual Weight
1	1	30.1	18.1	15	20	P	F	3	2	5	N	30.125	18	14.75	20
2	0	38.5	20	40	42	P	F	41	N/A	41	P	38.125	40.75	20.625	51
3	2	31.75	35.75	19	112	P	F	30	7.25	46	P	34	46	18	93
4	2	30	36	17	102	P	P	41	N/A	60.5	P	30	35.5	17.125	91
5	3	31	27	14	50	P	F	45	6.625	45	N	29.375	24	14.9375	64
6	3	26.75	28.5	11.75	41.2	P	F	0.5	0.875	11	F	27	28.5	11.875	39
7	3	31.187	28.5	15.687	65	P	F	10	6.5	31	P	31.5	28.5	15.75	51
8	3	28.125	27.5	15.75	47.8125	P	F	11	4.25	23	P	28.125	27.625	15.625	45
9	3	40	30.5	15.375	75	P	F	47	7.75	47.5	P	40.375	30.5	15.375	74
10	3	40	19.5	50	99	P	P	40+	N/A	***	P	39.5	49.75	19.5	95
11	3	35	33.5	19.13	90	P	P**	17	N/A	57	P	38	33.5	19.25	90
12	5	31	54	18	85	P	F	9.5	4.875	90.36	P	49	33	17.875	68
13	3*	33.03	41.3	20.08	94.8	P	P	74	N/A	82	P	33.5	41.375	20.25	94
14	3*	33.5	45	19	105	P	P	56	N/A	73	F	33.5	45	19	100
15	3	32	57	18	101	P	P***	***	***	66	F	32	57.125	17.75	100
16	3	47.008	30.079	16.693	119	P	P	73	N/A	32.67***	P	47.25	30	19.375	99
17	3	33.5	42	19	113	P	P	37	16	65	F	33	42	19	108
18	3	33.5	42.5	19	114	P	P	49	N/A	50***	F	33.625	42.75	19.125	113
19	3	32.5	53.5	16.5	118	P	P**	30***	***	63	N	32	53.25	16.5	117
20	4	33.75	38	18.75	70	P	P	48	N/A	23	P	44.875	36	18	96
21	4	46.25	29.5	58	61.6	P	F	3.5	4.75	70***	N	32.25	27.5	15.875	59
22	4	44	36	18	48	P	P	70	N/A	61	P	44	35.5	17.75	99
23	4	41.57	31.57	15.71	74.74	P	P**	34	N/A	40+	P	43.125	32	18.5	75
24	4	39	27.5	15.5	75	P	F	32	N/A	23	P	39	27.5	15.5	71
25	4	38	33.5	20	90	P	F	4	5.875	54.9	N	36.25	36.125	16	68
26	4	41.5	36	21.5	109	P	F	12.5	14.625	55	P	41	35.5	21.125	122
27	4	35.5	41	18	95	P	P**	43	N/A	53.9	P	40.875	35.5	18.875	69
28	4	36	36.25	16.75	94	P	F	46.5	7.75	63	N	35.75	36.125	16.75	88
29	4	42.677	34.724	18.583	114	P	P	35	N/A	45	P		34.75	18.5	106
30	4	34	41	19	118	P	F	13	11.5	28	N	34.125	41	19.375	93
31	4	36.75	36	16.5	110	P	F	11	5.125	35	P	36.5	36	16.5	57
32	5	51.63	18	24.19	45	P	F	7	10	39	N	51.75	24.25	18	88
33	5	40.25	17	13.5	55	P	F	27	4.75	43.54	P	40.25	17.125	13.4	53
34	5	42.75	28.5	11.75	62	P	F	0.8	3.875	25	P	42.625	28.5	11.875	60
35	5	45	31	16	76	P	F	5	8	42	P	44.5	30.75	15.75	88
36	5	44.125	32	17	83	P	F	6.5	8.375	47***	N	43.875	31.875	16.75	89
37	5	42.25	31.5	16	87	P	***	15	***	9***	N	45.25	31.5	15.75	74
38	5	45	31	16	90	P	F	2	9	43	P	44.375	31	16	88
39	5	46.65	37	17.5	94.6	P	P	26	N/A	59	P	46.5	37.25	17.5	93
40	5	42.25	31.5	16	92	P	F	26	***	13***	P	45	37.5	16	71
41	5	61	22	42	130	P	P	90	N/A	90+	N	60.75	20.375	42	116
42	5	48	43	18.5	143	P	P	47	N/A	72.8	P	48.25	40	18.5	111
43	5	48	32	16	108	P	F	39	7.125	45	P	48.5	31.625	15.875	100
44	6	57	25	17	45	P	P	52	N/A	***	P	57.5	24.5	16.875	94
45	6	48.5	37	19	52	P	P	18	N/A	62.22	F	48.5	37.375	19.125	108
46	3*	31.75	18	48	85	P	P	55	N/A	***	P	32	48	18	86
47	3*	32	52	18.75	92.4	P	***	17	***	76.14	N	32	51.625	18.625	97
48	6	44.5	28.5	15	74	P	F	29	7.25	85	N	44.625	28.5	15.875	77
49	6	36	36	16.5	77	P	F	24	9	17.54	P	36	36	16.5	79
50	3*	29.5	47.5	17	93	P	F	18	***	54.3	N	29.5	47.5	17	100
51	3*	28.25	47.62	15.62	91.9	P	P***	14	***	49	P	29.75	47.5	15.75	91
52	6	53	28.38	18.75	95	P	F	30	12.5	55***	P	53	28.25	18.625	90
53	3*	31	59.25	17	111	P	P	35	N/A	58***	N	31.25	59.125	16.875	125
54	3*	28	58	16	109	P	P	18	N/A	44.52***	F	28	58.375	15.75	94
55	3*	33	54	18	125	P	F	12	7.75	43.69	N	29	54	18	97
56	8	40.5	59	19	78	P	P	23	N/A	65	P	40.375	59	18.875	116
57	7	59.75	23.13	17.88	101.41	P	P	45	26	76***	N	30	66.125	17.375	160
58	8	31	52.5	16	100	P**	F	9	8.625	50	N	31.25	52.25	16	98
59	7	33.5	47.5	18.75	120	P	P	25.5	N/A	53	P	33.5	47.625	18.75	113
60	3*	31	54	18	85	P	F	8.5	6.125	24	P	31	54	18	71
61	6	66.5	46	20	290	P	P	50	N/A	100+	F	67	44.5	20.5	267

*	Double wide (6 drawers total)	**	Both rear feet came off the ground	N	No Tip Restraint
		***	Drawer broke, test could not be completed	F	Failed F3096
		P***	Drawer broke but unit did not tip over	P	Passed F3096
		F***	Drawer broke and unit tipped over		

TAB B

ESHF STAFF MEMORANDUM,

"ASTM F2057 – 14 WARNING LABELING REQUIREMENTS: MARKET COMPLIANCE AND VOLUNTARY STANDARD EVALUATION"

UNITED STATES
CONSUMER PRODUCT SAFETY COMMISSION
ROCKVILLE, MD 20850

MEMORANDUM

DATE: August 10, 2016

TO: John Massale, Project Manager, Furniture Tipover
Division of Mechanical Engineering, Directorate for Laboratory Sciences

THROUGH: Rana Balci-Sinha, Director,
Division of Human Factors, Directorate for Engineering Sciences

FROM: Hope E J. Nesteruk, Human Factors Engineer, and
Timothy P. Smith, Senior Human Factors Engineer,
Division of Human Factors, Directorate for Engineering Sciences

SUBJECT: ASTM F2057–14 warning labeling requirements: market compliance and voluntary standard evaluation

BACKGROUND

The ASTM International (ASTM) voluntary standard ASTM F2057-14, *Standard Safety Specification Clothing Storage Units*, establishes requirements for free-standing clothing storage units such as dressers, chests, and armoires, in United States, and is intended to minimize the hazards associated with tipover. ASTM developed this voluntary standard in response to incident data supplied by staff of the U.S. Consumer Product Safety Commission (CPSC or Commission). The current, published version of the voluntary standard is ASTM F2057 – 14. In the Fiscal Year 2016 Operating Plan, the Commission directed staff to prepare a briefing package related to furniture tipover to address:

- current market levels of compliance with ASTM F2057– 14, including an approximation, based on available information, of the market share of each of the models found not to be in compliance;
- ASTM F2057– 14's effectiveness when considering foreseeable misuse; and
- whether ASTM F3096-14[1] limits the use of more easily installed anchoring systems and potential alternative solutions.

This memorandum, prepared by staff of CPSC's Directorate for Engineering Sciences, Division of Human Factors (ESHF), focuses on the likely effectiveness of the hazard-communication aspects of the voluntary standard in addressing the risk of injuries and deaths associated with the use of clothing storage units. Specifically, ESHF staff focused on the following hazard-communication aspects related to the first two bullets of this requested briefing package:

[1] *Standard Performance Specification for Tipover Restraint(s) Used with Clothing Storage Unit(s).*

- an evaluation of the warning labels on each available dresser, to assess conformance to ASTM F2057– 14; and
- an evaluation of the warning requirements of ASTM F2057– 14 to effectively communicate the hazards identified by incident data.

DISCUSSION

CURRENT ASTM WARNING REQUIREMENTS

ON-PRODUCT WARNING REQUIREMENTS

Section 4.6 of ASTM F2057 – 14 states:

> 4.6 A permanent warning label (see Fig. 2) shall be attached to the clothing storage unit in a conspicuous location when in use.

The full color version of the required warning referenced as "Fig 2:" in ASTM F2057 – 14 is shown below. Given that the language in the standard does not state that Fig 2 is an "example" or that the warning content must be "addressed," as is common in many other ASTM standards, ESHF staff, therefore, interprets section 4.6 to mean that this exact label, with one of the two statements identified as "select based on product design" shall appear on all clothing storage units. However, the language in 4.6 is open to interpretation because it lacks the specificity that the label must be *the* label shown in Fig. 2, and does not use phrases like "shall state" or "exact" for clarification. The remainder of this analysis is based on ESHF staff's stated interpretation of section 4.6 and that the warning shown below is the required warning for clothing storage units.

Permanency

Although a number of ASTM voluntary standards under the F15 umbrella include performance requirements for label permanency, ASTM F2057 – 14 has no such requirements, despite stating in section 4.6 that the label must be "permanent." One comparable standard is F2388 – 16,

Standard Consumer Safety Specification for Baby Changing Tables for Domestic Use, which includes wooden and furniture-like changing tables. This standard includes a performance requirement that the label cannot be removed, tears into pieces upon removal, or that attempts to remove the label would damage the surface to which the label is attached. In addition, F2388 includes an adhesion test for warnings applied directly to the surface of the product, which uses a standard test procedure outlined in ASTM D3359, *Test Methods for Measuring Adhesion by Tape Test*.

Placement

There are no requirements related to the placement of this warning label, other than "a conspicuous location when in use." Although some standards (*e.g.*, many of the durable nursery product standards) address placement by defining "conspicuous" in a manner that describes when the warning must be visible to the consumer, ASTM F2057-14 does not define conspicuous.

Form

Rather than specifying format and colors in the text of the standard, ASTM F2057 – 14 identifies various form and format requirements within the "Fig 2" warning. Specifically, the signal word must be in 16-point font, the message panel text must be in 10-point font, there must be a black border around the warning label and separating the signal and message panel, the background of signal word panel must be either safety orange, black, or white, and the message panel must be black text on a white background. In addition, hazard avoidance statements are presented in outline format.

When assessing the adequacy of a warning, one must consider not only the content of a warning, but its design, or "form" (Laughery & Wogalter, 2006; Madden, 1999; Madden, 2006). ESHF staff regularly use ANSI Z535.4, *American National Standard for Product Safety Signs and Labels*—the primary US. voluntary consensus standard for the design, application, use, and placement of on-product warning labels—when developing or assessing the adequacy of warning labels. Human factors and warnings literature regularly cite ANSI Z535.4 when discussing the design and evaluation of on-product warning labels, and identify it as the minimum set of requirements that products containing such labels that are sold in the U.S. should meet (*e.g.*, Vredenburgh & Zackowitz, 2005; Wogalter & Laughery, 2005). Hellier and Edworthy (2006) and Peckham (2006) report that this has been reaffirmed by the U.S. courts, who have accepted the ANSI Z535 series of standards in general, and the ANSI Z535.4 standard in particular, as the benchmark against which warning labels are evaluated for adequacy, because these standards are seen as the state of the art (also see Laughery & Wogalter, 2006). Furthermore, the scope of ANSI Z535.4 is broad enough to encompass nearly all products.

Based on the formatting requirements identified in "Fig 2," ESHF staff concludes that warning in ASTM F2057 – 14 is consistent with the requirements in ANSI Z535.4.

Content

Rather than providing a series of statements that the manufacturer "shall address," the standard references a figure showing a warning label with multiple statements and in several color options. The required warning label shown in figure 2 of ASTM F2057-14 includes two hazard description statements, one hazard consequence statement, and five hazard avoidance statements, one of which is to be selected from the two alternative statements indicated in "Fig. 2" by: (1) the phrase "select based on product design," (2) two arrows[2], and (3) the word "(OR)" embedded within the text of the warning label. The specific statements required for each warning label is shown below.

ASTM F2057-14 warning statements: Units **without** drawer interlock	ASTM F2057-14 warning statements: Units **with** drawer interlock
WARNING	WARNING
Serious or fatal crushing injuries can occur from furniture tipover. To help prevent tipover: - Install tipover restraint provided. - Place heaviest items in the lower drawers. - Unless specifically designed to accommodate, do not set TVs or other heavy objects on top of this product. - Never allow children to climb or hang on drawers, doors or shelves. - Never open more than one drawer at a time **Use of tipover restraints may only reduce, but not eliminate, the risk of tipover.** This is a permanent label. Do not remove.	**Serious or fatal crushing injuries can occur from furniture tipover. To help prevent tipover:** - Install tipover restraint provided. - Place heaviest items in the lower drawers. - Unless specifically designed to accommodate, do not set TVs or other heavy objects on top of this product. - Never allow children to climb or hang on drawers, doors or shelves. - Do not defeat or remove the drawer interlock system **Use of tipover restraints may only reduce, but not eliminate, the risk of tipover.** This is a permanent label. Do not remove.

ASSESSMENT OF SAMPLE CLOTHING STORAGE UNITS LABELING

In order to assess likely market compliance with the voluntary standard, a convenience sample of 61 free-standing clothing storage units was purchased and shipped to CPSC's National Product Test and Evaluation Center (NPTEC). Staff from CPSC's Directorate for Laboratory Sciences,

[2] HF staff recognizes that the arrows in Figure 2 appear to be about one-half to one line above the statements that are to be chosen between, which could create some confusion; however, the "(OR)" clarifies which two statements are options.

Division of Mechanical Engineering (LSM) evaluated each product to the performance requirements and test methods of ASTM F2057 – 14. ESHF staff evaluated each unit for the hazard communication requirements in section 4.6.

Of the 61 clothing storage units available for evaluation, 34 (56%) contained a warning label related to tipover hazards; however, the tipover warning labels varied greatly among units. A summary of findings, including some of the common interpretations of the label in "Fig. 2" are listed below. Note that percentages are based on the total number of clothing storage units evaluated.

- Only five (8%) of the labels were fully compliant with Figure 2 in the voluntary standard, including selecting the appropriate statement based on product design.
- Three (5%) contained an exact replica of the warning required by Section 4.8, including both of the statements that are intended to be mutually exclusive and the "(OR)."[3]
- Twenty-one (34%) included both of the mutually exclusive statements, sixteen of these included the "(OR)" that is shown in Fig. 2.
- Ten (16%) included the statement "Install tipover restraint provided," while two (3%) included a similar statement that was modified.
    - Three of the 10 units that included "install tipover restraint provided" statement did *not* provide a tipover restraint.
    - Twenty of the 22 units that did *not* include the "install tipover restraint provided" statement *did include* a tipover restraint with the unit, although 2 of those failed the section 4.5 of ASTM F2057 – 14, which assesses the performance of the tipover restraint by testing the restraint as specified in ASTM F3096-14.
- Ten (16%) modified the line "Unless specifically designed to accommodate, do not set TVs or other heavy projects on top of this product," to remove the "Unless specifically designed to accommodate" portion of the sentence. Although there is nothing in the voluntary standard to allow this modification, the modification is actually appropriate because it allows the manufacturer to clearly identify units not meant for a TV rather than putting the onus on the consumer to know if the unit is appropriate.
- Four (7%) also included the "Fall Hazard" warning that is required for changing tables in F2388. Three of these four clearly also functioned as changing tables; however one was 53 inches tall and did not include barriers typical of changing tables.

Although staff did not conduct any tests regarding warning label permanence, when examined by ESHF staff, the warning labels on several clothing storage units were bubbled, peeling, or were no longer sticking to the unit. Peeling and bubbling is evidenced in the warning photos in Figure 1.

[3] "Never open more than one drawer at a time" and "Do not defeat or remove the drawer interlock system"

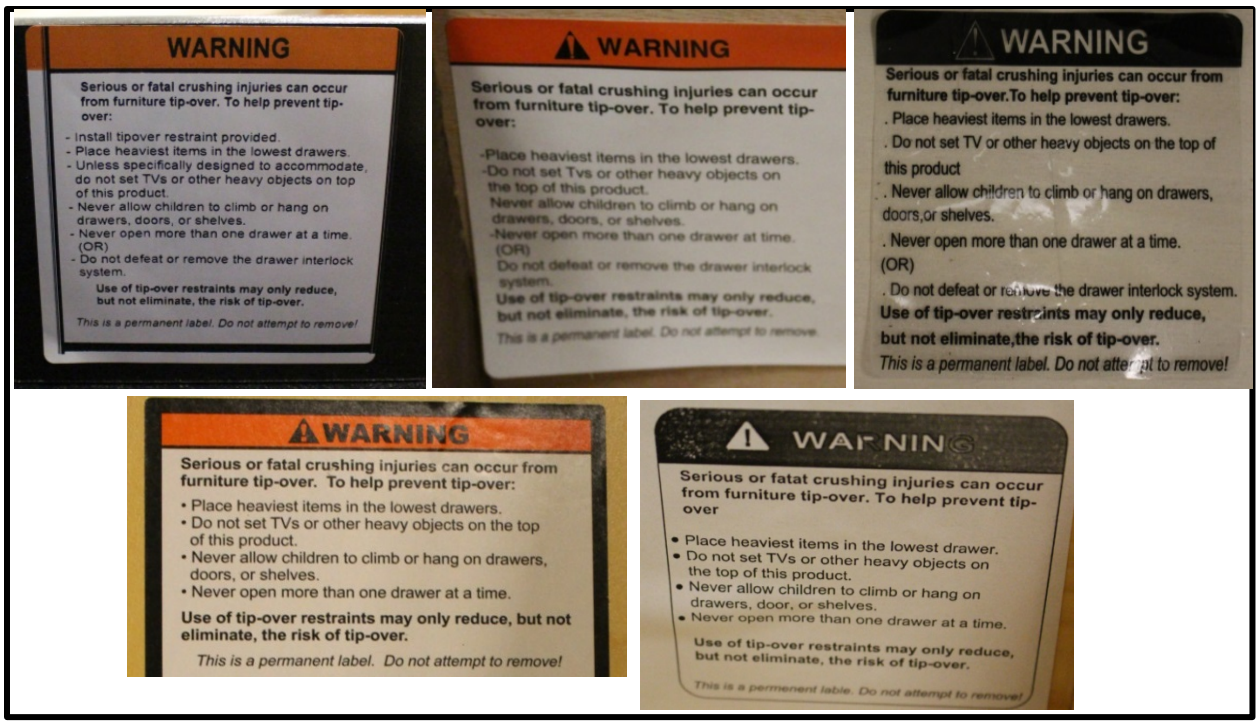

Figure 1. Peeling and bubbling see on some units

Although all 33 of the units that included a warning label related to tipover hazards had the tipover warning inside of a drawer, the precise location inside the drawer varied between units. In addition, many units had drawers that could be installed in multiple locations by the consumer during assembly or moved during regular use, which means the final warning placement depends on where the consumer places the particular drawer. Table 2Table 2 shows the distribution of warning placement locations. The majority of warnings were located inside of drawers; however, two were found on the backside of the dresser, *i.e.* the side that would be against a wall.

Table 2. Warning label placement

Location	Number	Percent
Bottom panel of drawer	12	35%
Left* side panel of drawer	12	35%
Back* vertical panel of drawer	1	3%
Right* side panel drawer	7	21%
Back side of dresser (against wall)	2	6%
	34	100%

* Left, right, and back as observed when facing drawer

ESHF STAFF ASSESSMENT OF WARNING REQUIREMENTS IN ASTM F2057 – 14

LIKELY EFFECTIVENESS ASSESSMENT OF CURRENT WARNING REQUIREMENTS

For a warning to be effective, the consumer must do three basic things:

a) Notice the warning – Conspicuity is essential to getting a warning noticed. Signal words, colors, graphics, and placement all increase conspicuity

b) Read the warning – Many things affect the likelihood that the label will be read, such as familiarity and perceived hazard, along with visual display issues, such as readability. Studies have found that the more familiar a consumer is with a product, the less likely he or she is to look for or read a warning (*e.g.*, Wogalter and Leonard, 1999).

c) Heed the warning – When personal experience conflicts with a warning message, consumers generally will discredit and ignore the warning message (Ayers, Gross, Wood, Horst, Beyer, and Robinson, 1986). However, providing more explicit or detailed information in a warning has been found to increase warning effectiveness (Laughery & Smith, 2006), and vividness has been found to increase message salience, which triggers one's motivation to act (Murray-Johnson & Witte, 2003).

A breakdown in any of these three places will prevent the warning from being effective. Thus, an effective warning must be carefully written, designed, and placed in ways that will increase the likelihood that consumers will notice, read, and heed the warning.

Content

The primary U.S. voluntary consensus standard for product safety signs and labels, ANSI Z535.4, *American National Standard for Product Safety Signs and Labels*, as well as other literature and guidelines on warnings (*e.g.*, Robinson, 2009; Wogalter, 2006; Wogalter, Laughery, & Mayhorn, 2012) consistently recommend that on-product warnings include:

- a description of the hazard,
- information about the consequences of exposure to the hazard, and
- instructions regarding appropriate hazard-avoidance behaviors.

ESHF staff evaluated each of statements required by ASTM F2057–14 for their adherence to the warning design principles that increase warning effectiveness and summarized the findings in Table 3.

Table 3. Factors that affect the likely effectiveness of F2057-14 warning statements

ASTM F2057-14 warning statements:	ESHF Evaluation of statement
Serious or fatal crushing injuries can occur from furniture tipover. To help prevent tipover:	The leading statement on the warning label lacks the explicit linkage to incidents that have occurred (*e.g.*, "Children have died…"). In addition, using "help" to modify "prevent" diminishes the power of the hazard avoidance statements that follow by implying the hazard avoidance behaviors might not be sufficient to fully address the hazard.
- Install tipover restraint provided.	This is a positively phrased statement to address hazard avoidance; however, improvement is possible by emphasizing the need to secure the furniture to the wall, rather than just installing it on the product, as well as the importance of this action under all circumstances (*e.g.*, "ALWAYS secure this furniture to the wall"). In addition, "tipover restraint" terminology might confuse some users. This is because restraints generally describe what they contain (*e.g.*, child restraint, pet restraint) rather than what they prevent. Terminology such as "anti-tip device" might be clearer and is consistent with "anti-tip brackets" used for a kitchen range.
- Place heaviest items in the lower drawers.	This is a positively phrased hazard avoidance statement; however, staff believes that it would be more appropriate to state that consumers should place the heavi*est* items in the low*est* drawers.
- Unless specifically designed to accommodate, do not set TVs or other heavy objects on top of this product.	As phrased, this statement requires the consumer to recognize and recall if the specific clothing storage unit was "specifically designed to accommodate" what is implied to be "TVs or other heavy objects." This statement also requires consumers to infer what objects are likely to be "heavy" enough to avoid being placed on the unit. Rather than including the statement on every clothing storage unit, the statement should only appear on units for which it is true. That is, clothing storage units designed to accommodate a TV would not need to include this warning, and its inclusion on such a unit might reduce the overall effectiveness of the warning.
- Never allow children to climb or hang on drawers, doors or shelves.	Although this statement is supported by incident data, ESHF staff believes the credibility could be strengthened by including other common hazard scenarios. Specifically, a child standing on the

	bottom drawer in order to reach something in the upper drawers or on top of the unit may not be understood by caregivers to be equivalent to climbing. As phrased currently, the statement might be interpreted to only apply to children that climb dressers for challenge and amusement; however, a number of incidents involve children trying to access clothing in upper drawers – a typical use of a clothing storage unit.
- Never open more than one drawer at a time	This statement lacks credibility due to the typical and foreseeable use patterns. Consumers might often need to open more than one drawer at a time – for example when moving clothing from one drawer to another or putting fresh laundry away – and some dressers might include non-full-width drawers that would facilitate this use.
(OR)	As shown in the sample evaluation section of the memorandum, the use of "(OR)" on the example warning label has produced confusion in the industry, with 33% of samples including both statements.
- Do not defeat or remove the drawer interlock system	This message is an appropriate hazard avoidance statement for units that include a drawer interlock system.
Use of tipover restraints may only reduce, but not eliminate, the risk of tipover.	Although staff understands the logic of including this statement, its presence in the warning is likely to have the unfortunate effect of dissuading consumers from using the tipover restraints. One of the major factors that determines whether consumers will comply with a warning is the perceived efficacy of the recommended hazard-avoidance behavior (DeJoy, 1999). Consumers who do not believe that use of a tipover restraint is likely to be effective in eliminating the hazard are likely to reject the warning message. This might be especially the case for the installation of tipover restraints, because installing these devices is often challenging, time-consuming, and effortful. Warnings research has shown that even small inconveniences can have a substantial negative effect on behavioral compliance with a warning (Riley, 2006).
This is a permanent label. Do not remove.	This is a non-warning statement. In addition, a statement that a consumer should not remove the warning is not a substitute for permanency requirements.

Placement

ASTM F2057–14 states that the warning must be located in "a conspicuous location when in use." As shown in Table 2Table 2, this location varied greatly among clothing storage units sampled. Of the units that contained a tipover warning, 41 percent of those warnings were located on the rear or bottom panel of a drawer – a location that would not be visible once clothing items are placed inside the drawers. In addition, warning labels placed on the side panels of the drawers might become obscured once clothing is added to the drawers. Although ESHF staff acknowledges that identifying an ideal location for a tipover warning might be difficult due to consumer resistance to a warning on the visible outside of furniture, staff believes it would be possible to improve consistency between clothing storage units and to identify a location that would be more conspicuous than many of the locations observed. Proper placement of the warning label is a key factor in providing that a warning label is noticed and read, which in turn is key in the likely effectiveness of the warning.

CONCLUSIONS

ESHF staff reviewed the convenience sample of 61 clothing storage units for warning labeling compliance with ASTM F2057–14 and found that manufacturers are inconsistent in their interpretation of and adherence to the warning requirements contained in section 4.6 and Fig. 2 of ASTM F2057–14. In addition, ESHF staff found significant opportunities to improve warning effectiveness by revising the requirement contained in the voluntary standard, specifically:

- Strengthening requirements for permanency.
- Identifying a conspicuous location on clothing storage for the warning label.
- Allowing for better customization of hazard avoidance statements based on unit design, *i.e.*, allowing manufacturers to select which hazard communication messages are applicable to each model.
- Comparing warning messages with incident data to make sure that the known hazardous situations are identified.
- Revising the message panel text in a manner that is understandable and does not contradict typical clothing storage unit use and in ways that motivates consumers to comply.

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TAB C

LSM STAFF MEMORANDUM,

"VALUE AND LIMITATIONS OF ASTM F3096-14 STANDARD PERFORMANCE SPECIFICATION FOR TIPOVER RESTRAINT(S) USED WITH CLOTHING STORAGE UNIT(S)"

UNITED STATES
CONSUMER PRODUCT SAFETY COMMISSION
ROCKVILLE, MD 20850

MEMORANDUM

DATE: September 30, 2016

TO: Furniture Tipover Project File

THROUGH: Andrew Stadnik, P.E.,
Associate Executive Director for Laboratory Sciences

Michael Nelson
Director, Division of Mechanical Engineering

FROM: John Massale, P.E., Mechanical Engineer
Directorate for Laboratory Sciences, Division of Mechanical Engineering

SUBJECT: Effectiveness and limitations of ASTM F3096-14 *Standard Performance Specification for Tipover Restraint(s) Used with Clothing Storage Unit(s)*

BACKGROUND

The ASTM International (ASTM) voluntary standard ASTM F2057-14, *Standard Safety Specification Clothing Storage Units*, establishes requirements for free-standing clothing storage units, (CSU) such as dressers, chests, and armoires, the in United States, and is intended to minimize the hazards associated with tipover. ASTM developed this voluntary standard in response to incident data supplied by staff of the U.S. Consumer Product Safety Commission (CPSC or Commission). The current version of the voluntary standard is ASTM F2057-14. Part of ASTM 2057-14 references ASTM F3096-14 S*tandard Performance Specification for Tipover Restraint(s) Used with Clothing Storage Unit(s).* In the Fiscal Year 2016 Operating Plan, the Commission directed staff to prepare a briefing package related to furniture tipover to address:

- Current market levels of compliance with ASTM F2057-14, including an approximation, based on available information, of the market share of each of the models found not to be in compliance;
- ASTM F2057–14's effectiveness when considering foreseeable misuse; and
- whether ASTM F3096-14 limits the use of more easily installed anchoring systems and potential alternative solutions.

This memorandum focuses on the limitations associated with ASTM F3096-14.

HISTORY OF ASTM F3096-14

ASTM F2057-09 was published in 2009 and was the first iteration of that voluntary standard containing provisions for the inclusion of a tipover restraint device, (TRD), with the CSU. Section 3 of the voluntary standard states:

> 3.4 Tipover restraints shall be included with each item of furniture covered under the scope of this standard for attachment by the consumer to the interior wall, framing, or other support and the case good to help prevent tipover.
> 3.5 If a cable or strap type restraint is used, the strap must be tightened with no slack allowed when installed between the wall and case.
> 3.6 The tipover restraint provided and recommended method of attachment shall withstand a pull force of 50 lb.
> 3.7 Instructions shall be supplied with each unit providing clear and complete installation instructions.

ASTM F2057-09 did not specify what type of TRD should be included, only that it withstand a pull force of 50 pounds. It did specify that instructional literature be provided. There were no performance metrics that explicitly stated pass/fail criteria.

The most recent version of the standard, ASTM F2057-14, references ASTM F3096-14 as the location for the requirements pertaining to TRDs. Specifically, ASTM F2057-14 states:

> 4.4 Tipover restraints shall be included with each item of furniture covered under the scope of this safety specification for attachment by the consumer.
> 4.5 The tipover restraint provided shall meet the requirements of Specification F3096.

ASTM F2057-14 was published concurrently with ASTM F3096-14. This was the first publication for ASTM F3096-14.

ASSESSMENT OF ASTM F3096-14

The performance requirements of ASTM F3096-14 are found in Section 4. They prescribe a testing protocol for a single, linear pull test using a force of 50lb. Specifically, the standard states:

> 4.1 Assemble tipover restraint components including provided fasteners in accordance with manufacturer's instructions.
> 4.2 Rigidly suspend the assembly by securing one end of the tipover restraint by gripping directly, or attaching to a fixed structure (for example, wooden block). See Fig. 1 for test method examples for commonly used tipover restraints.
> 4.3 Attach a loading device to the fastener(s) on the opposite end of restraint.
> 4.4 Gradually, over a period of not less than 2 seconds nor greater than 15 seconds, apply the static load of 50 lb (23 kg), and maintain for an additional 30 s.
> 4.5 If the fastener(s) become unattached from the test structure (wood block or fixed structure) in such a way that it prohibits the completion of the test, then the fastener(s) are to be reattached using whatever means possible without affecting the test results of the assembly.

Staff identified six major limitations with this test method.

First, the test method only applies to strap-style TRDs. The pull test assumes a linear connection between a restraint and its attachment means. A lightbulb hanging from a ceiling is a linear connection. Any style of restraint that is not a linear connection cannot be tested without subjecting the TRD to non-representative forces. An L-bracket or hook, which could potentially be used as an "attachment means" for a strap-style TRD would be subjected to torsional or shear forces by a linear uniaxial pull test. The off-axis loading of the bracket or hook would not be representative of a real-world situation. For example, hanging clothes from a light bulb mounted to a wall, projecting horizontally into a room, would cause the lightbulb mounting to bend downward due to leverage. Clothes hung from the first dangling lightbulb would load the lightbulb in one axis.

A TRD that involves a more complicated design cannot be tested by a single pull force. For example, if a CSU begins to tip, but has a gravity activated braking device, drop-down legs, or break-away drawers, this standard cannot currently assess those innovations

Second, a strap-style TRD is typically attached to the back of the CSU, then to a consumer's wall forming a chain with four linking juncture points;

- CSU to attachment means,
- attachment means to strap/cord,
- strap/cord to attachment means,
- attachment means to wall.

This test method only subjects one of the four junctures to stressing forces, attachment means to strap/cord. The integrity of the strap and attachment means are also internally stressed, meaning the molecules of the strap want to tear themselves apart, but neither the remaining three junctures nor their individual components are examined.

Third, the first test method 4.1 is "assembled according to the manufacturer's instructions." Section 4.2, which immediately follows, contradicts the manufacturer's instructions by requiring ? attaching of the restraint to a block of wood or "rigidly suspend[ing]" the strap. Unless the manufacturer's instructions explicitly state the consumer should attach the restraint directly to a wooden block, the information in test methods 4.1 and 4.2 directly conflict. Also, because the test specifies a wooden block, materials more likely seen by the attachment means are not simulated, such as drywall and laminated composite woodboard.

Fourth, the timing of the test in 4.4 is not representative of a scenario where a child steps on an open drawer. In order to propel themselves vertically up, the child may exert an impulsive force downward. Impulsive forces, by nature, are not gradually applied. A 2- to 15- second window is far too long to be representative of the hazard scenario. A child

may gingerly step up, gradually applying their load, but impulse loading is a more onerous scenario and is foreseeable. Other standards[9] addressing issues associated with impulsive forces instruct the investigator to drop a weight through one inch of vertical space to simulate an impulse force.

Fifth, the 50 lb force of Section 4.4 is supposed to simulate the weight of a child stepping on the front of the unit. However, forces seen in a properly installed strap style TRD may not be 50 lb in a linear direction. As a clothing storage unit rotates away from a wall, it would introduce horizontal and vertical impulsive forces on the restraint. The magnitude of the force components would depend on the geometry and weight distribution of the CSU. A child stepping on an open drawer introduces leverage against the restraint. The length of that lever arm can magnify or minimize the forces seen at the restraint junctures. This phenomenon was further discussed in the May 2015 report, "Preliminary Evaluation of Anchoring Furniture and Televisions without Tools[10]."

Sixth, Section 4.5 instructs the investigator to reattach the fasteners to the wood block or "rigid structure" if the fasteners disengage, until the test is completed. This means that the fasteners are not considered part of the assembly. If the fasteners cannot remain properly secured to a wooden block, then they are unlikely to remain secured to drywall. Furthermore there is no limit to the number of times the fasteners can be reattached. The reattachment provision of Section 4.5 eliminates yet another portion of the four-juncture-chain from being tested.

CONCLUSION

ASTM F3096-14 does not allow for an innovative restraint design because it focuses solely on the strap-style restraint. Furthermore the voluntary standard does not appropriately examine all the parts of the strap-style, *e.g.*, the brackets and fastener. ASTM F3096-14 does not simulate the likely materials with which a tip restraint device is intended to be used. Also, F3096-14 contains no explicit pass or fail criteria.

[9] ASTM F2012-16 *Standard Consumer Safety performance Specification for Stationary Activity Centers*
[10] https://www.cpsc.gov//PageFiles/182505/TipoverPreventionProjectAnchorswithoutTools.pdf

TAB D

ESHF STAFF MEMORANDUM,

"HUMAN FACTORS ASSESSMENT OF FURNITURE TIPOVER INCIDENTS"

UNITED STATES
CONSUMER PRODUCT SAFETY COMMISSION
ROCKVILLE, MD 20850

MEMORANDUM

DATE: August 10, 2016

TO: John Massale, Project Manager, Furniture Tipover
Division of Mechanical Engineering, Directorate for Laboratory Sciences

THROUGH: Rana Balci-Sinha, Director,
Division of Human Factors, Directorate for Engineering Sciences

FROM: Hope E J. Nesteruk, Human Factors Engineer,
Division of Human Factors, Directorate for Engineering Sciences

SUBJECT: Human Factors Assessment of Furniture Tipover Incidents

BACKGROUND

The ASTM International (ASTM) voluntary standard ASTM F2057, *Standard Safety Specification Clothing Storage Units*, establishes requirements for free-standing clothing storage units such as dressers, chests, and armoires, in the United States, and is intended to minimize the hazards associated with tipover. ASTM developed this voluntary standard in response to incident data supplied by staff of the U.S. Consumer Product Safety Commission (CPSC or Commission). The current, published version of the voluntary standard is ASTM F2057–14. In the Fiscal Year 2016 Operating Plan, the Commission directed staff to prepare a briefing package related to furniture tipover to address:

- Current market levels of compliance with ASTM F2057–14, including an approximation, based on available information, of the market share of each of the models found not to be in compliance;
- ASTM F2057–14's effectiveness when considering foreseeable misuse; and
- Whether ASTM F3096-14[11] limits the use of more easily installed anchoring systems and potential alternative solutions.

This memorandum, prepared by staff of CPSC's Directorate for Engineering Sciences, Division of Human Factors (ESHF), focuses on the human behavior and foreseeable use and misuse scenarios associated with clothing storage units as identified in CPSC incident databases. Specifically, Directorate for Laboratory Science's Division of

[11] *Standard Performance Specification for Tipover Restraint(s) Used with Clothing Storage Unit(s).*

Mechanical Engineering (LSM) staff requested a discussion of child behavior and other data, such as child weight, that could be used to develop recommendations for improving ASTM F2057. Therefore, ESHF staff reviewed relevant incident data to identify

- behavioral use patterns associated with incidents; and
- anthropometric factors, developmental milestones, and other child behavior factors that are likely to contribute to incidents.

Note that the scope of ASTM F2057–14 states that the standard is intended to address tipover injuries and deaths to children 5 years of age and younger related to "free-standing clothing storage units, such as chests, door chests and dressers, over 30 in. (762 mm) in height."

REPORTED FATAL INCIDENTS

Staff from the Directorate for Epidemiology, Division of Hazard Analysis provided ESHF staff 200 reported furniture-related fatalities occurring between 2000 and 2015. Of these 200 fatal incidents, 15 were related to furniture other than clothing storage units, such as bookcases and shelving, and an additional 26 incidents involved adult[12] victims. ESHF staff's analysis will focus on the remaining 159 clothing storage unit-related child fatalities.

Age of victim

One-hundred fifty-one (95%) of the 159 incidents involved children under 6 years old, with the majority of incidents involving victims between 2 and 5 years old, and the oldest child fatalities involved 8-year-old children. The two youngest children in the data set were a 3-month-old who was killed when an older sibling became tangled in the cord connected to a television sitting on a dresser and the dresser toppled on the 3-month-old. Additionally, an 8-month-old killed when an older sibling scaled a dresser to access a VCR and the dresser fell onto the 8-month-old. The youngest victims who personally interacted with a clothing storage unit that tipped were 11 months old, of which there were four.

[12] Although not relevant to the requested analysis, 20 incidents involved senior adults (60 years of age or older). The majority of the events were unwitnessed; however, there were indications in some incidents that the victim might have grabbed the clothing storage unit to maintain or regain balance.

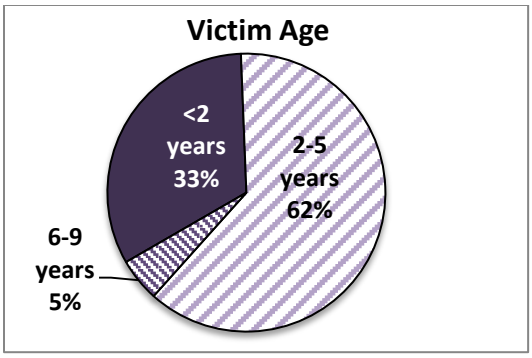

Figure 2. Age range of fatal child victims for clothing storage unit deaths

Developmental factors for children younger than 2 years old

Toward the end of a child's first year (8.6 months on average), infants begin using objects, such as furniture, to pull themselves to a standing position (Bayley, 1969; Therrell et al., 2002). As children pass through their first birthday they are learning about basic gross- and fine-motor skills while also gaining confidence in climbing, and also are learning to imitate common actions (Therrell et al., 2002). Between 19 and 23 months, children are more stable walking and begin exploring other skills, such as balancing and jumping, and can climb on and off furniture without assistance (Therrell et al., 2002). As children approach age 2, they begin to mentally consider solutions to problems before taking action (Therrell et al., 2002).

Developmental factors for children 2 through 5 years old

As children pass their second birthday, developmental factors that would draw them to interacting with clothing storage units increase. Two-year-olds are showing an interest in television and the characters on televisions, while 3-year-olds use the cartoon characters they watch on television as playmates (Therrell *et al.*, 2002). Because consumers sometimes place television sets on dressers and similar furniture, these children are likely to interact with this furniture. Four- and 5-year-olds are still very interested in television characters, although they have progressed to more action-oriented characters (Therrell *et al.*, 2002). Most parents are likely familiar with children's passion for their favorite cartoons during this age period.

As these children's gross- and fine-motor skills increase, they enjoy the challenge of exercising these skills by balancing, climbing, jumping, and similar activities (Therrell et al., 2002). Young children can jump off elevated surfaces at approximately 28 months (Bayley, 1969), and by three-years they are adept at climbing on play structures (Therrell et al., 2002).

Between 24 and 30 months (2 to 2.5 years), children are learning to undress themselves, although they typically need assistance to redress (Case-Smith & O'Brien, 2010). However, as they pass their third birthday and progress through their third year, children

become more adept at dressing themselves, while also developing a self-awareness and independence by wanting to do tasks without assistance (Case-Smith & O'Brien, 2010; Bee, 1992).

When taken together, these developmental factors help to explain why the data show that children age two to five are the most frequent victims of fatal furniture tipover events. These children are:

- exerting their independence by wanting to do tasks without adult assistance, even though they cannot yet recognize tasks for which they need assistance;
- at an age where climbing and jumping are an important part of normal development;
- learning to dress themselves;
- likely to try to reach a television set on top of a dresser in order to watch their favorite show; and
- developing and further refining problem solving skills.

Anthropometric factors

Although it was not possible to determine victim height and weight, or the height of the clothing storage unit, in all of the 159 cases reviewed, Table 4Table 4 displays descriptive statistics for the cases where this information was reported in the in-depth investigation (IDI) and when victim interaction[13] precipitated the tipover. ESHF staff found five cases where victim's reported weight exceeded 50 lb, which is the test weight used in ASTM F2057; all but one of these five victims was under 6 years of age. In one incident,[14] two children weighing 20 and 22 lb (total of 42 lb) were sitting in a lower drawer. Several other incidents[15] involve more than one child on the dresser, but the weight of the surviving child was not available. These data support previous ESHF staff work that concluded "the 95th percentile weight of 5-year-old children is likely to be about 60 pounds (27.2 kg) or greater" (Smith, 2016).

[13] In seven cases, one child was climbing or pulling on a dresser when the dresser fell onto a victim sitting on the floor. Because height and weight was typically obtained from victim autopsy reports, it was not available for the child that initiated the tipover event. Therefore, victim height and weight were recorded as not applicable and were not considered in any analysis.
[14] 140707HNE0001
[15] e.*g.*, 140702HCC1734, 130520HCC1823

Table 4. Descriptive statistics, when reported in IDI

	Victim Height, inches (n=87)	Victim Weight, pounds (n=86)	Unit Height, inches (n=88)
Minimum	24	18	24
Maximum	47	66	84
Mean	36.0	32.7	45.4
Median	35.5	30.0	46.5

n is the number of IDIs for which the given value was available.

Although ESHF staff was able to determine the height of only 88 involved units, the majority of known-height units were between 3 and 4 feet tall, as shown in Figure 3. In addition, for the 65 cases where ESHF could identify how many rows of drawers were in the incident unit, 49 cases involved units with four or five rows of drawers. Because there are a large number of unknowns in the above data, the analysis may not be representative of the entire data set. Therefore, ESHF staff cautions against drawing conclusions from these data. However, the data do suggest the units between three and four feet tall with four to five rows of drawers are most identifiable in the fatality data, which might be explained if three to four foot tall dressers are the most common size used in children's bedrooms. If three to four foot dressers with four or five rows of drawers are the most common size, it would be expected to be the most common size found in the data.

For 63 cases, both victim height and the height of the clothing storage unit were reported in the IDI. ESHF staff found that the victim was at least half the height of the clothing storage unit in all 63 cases, and was at least 70 percent as tall as the unit in over 80 percent of the 63 cases. Again there are a large number of unknowns in the above data, so the analysis may not be representative of the entire data set and caution must be exercised. Over ninety-five percent of children will exceed 25.2 inches (*i.e.*, 70% of three feet) by nine-months-of-age (Flegal and Cole, 2013). The largest boys will begin to exceed 33.6 inches (*i.e.*, 70% of four feet) by 17 months, while the smallest girls will not exceed 33.6 inches until 33 months (Flegal and Cole, 2013). As shown in Figure 4, most children 2 years old through 5 years old will be between 70 and 100 percent as tall as a four foot tall dresser (Flegal and Cole, 2013). Because the range of 24 inches to 48 inches range encompasses most children, the appearance of a correlation between child height and dresser height is likely to be simply an artifact of children's physical growth compared against typical dressers. In addition, the developmental growth factors discussed above that suggest children climb to reach the upper drawers and top of the dresser and to challenge themselves.

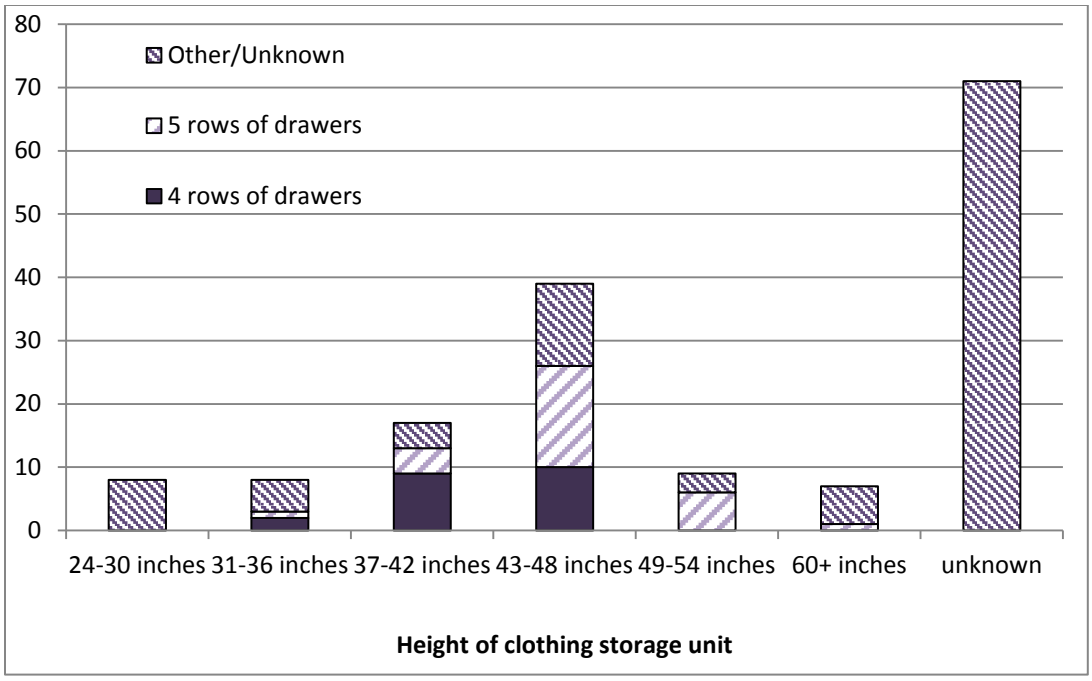

Figure 3. Number of fatal incidents per dresser height group

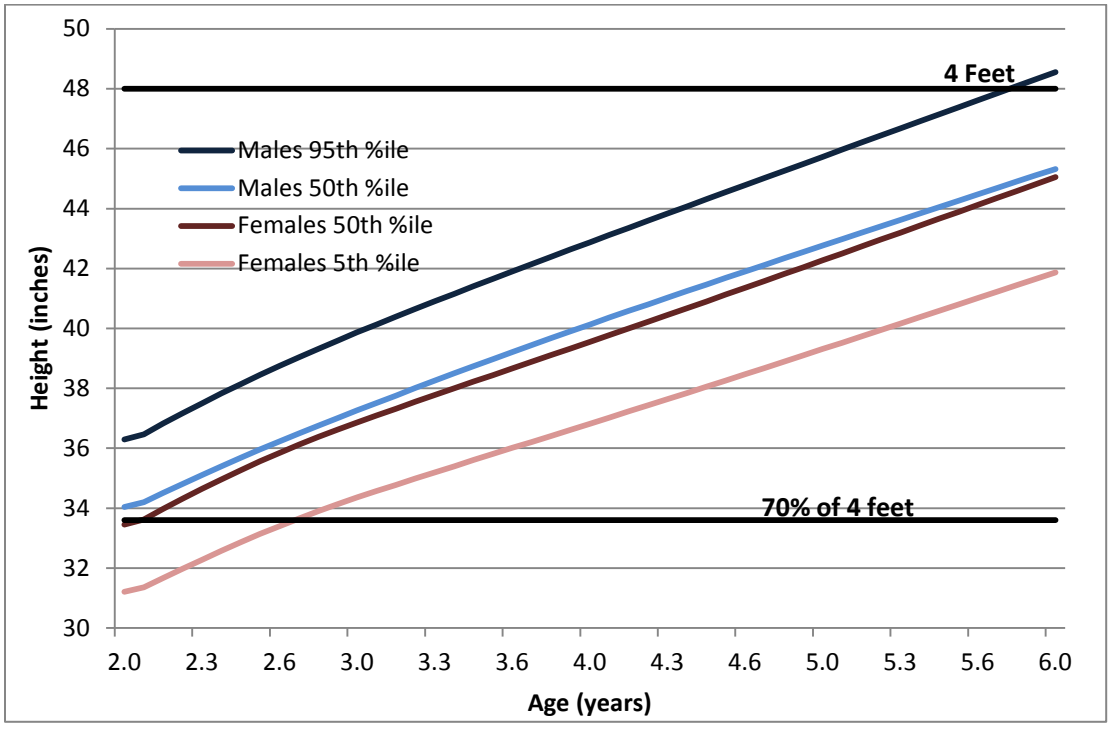

Figure 4. CDC Growth Chart age 2 to 6 years

Behavioral hazard patterns

*Clothing storage units **with** a television on top*

Eighty-four of the 159 fatalities in the current analysis involved both a television, generally an older cathode-ray tube (CRT) television, and a clothing storage unit (e.*g.*, dresser or chest of drawers). The hazard pattern of a child scaling a dresser using lower drawers in order to reach a television on top of a dresser has been well documented and has been the focus of a number of CPSC safety outreach videos. The developmental and anthropometric factors discussed above suggest that young children are likely to express the desire to watch television, are developing climbing and problem solving skills, and generally are shorter than clothing storage units, and therefore, are likely to stand on a lower drawer or otherwise climb a dresser to reach a television. The current data review continues to support that children use developmentally appropriate problem solving skills to scale dressers in order to reach televisions, as well as VCRs[16], DVD players[17], and video game systems[18] stored with televisions. Few of the television-related furniture tipover events indicated that children were involved in climbing for play purposes only, while many suggested that the child was climbing or standing on a lower drawer in order to reach the controls of a television or to access other items on top of a dresser or in upper drawers.

*Clothing storage units **without** a television on top*

Previous work (*e.g.*, Suchy, 2014) has reported that a large percentage of furniture tipover incidents are related to children climbing on furniture. In light of the developmental assessment discussed above, ESHF staff sought to further investigate the *reasons* children were climbing on clothing storage units, particularly units without a television on top. The current data set contains 75 fatal incidents that did not involve a television on top of a clothing storage unit.

For 32 of the 75 incidents, ESHF staff was unable to identify the primary behavior related to the tipover; however, in a few cases there were some contributing factors that provided an indication, such as: a child having a known history of climbing furniture,[19] items on top of dresser the child might have been reaching for,[20] or police investigators stating that the dresser was unstable when the drawers were opened.[21]

For the remaining 43 cases, ESHF staff found a variety of behaviors that contributed to the tipover, including children climbing onto and into dressers for play and also children climbing with a purpose. Examples of play behaviors seen in the data include: hide-and-

[16] e.*g.*, 001214HCC0159, 090902HEP9001
[17] e.*g.*, 120224HCC1438
[18] e.*g.*,040227HCN0383, 130812HCC3861
[19] e.*g.*, 151125HCC3193
[20] e.*g.*, 090326HCC1556, 090916HCC1066,120404HNE1300
[21] e.*g.*, 021210HWE5011, 030113HCN0261, 050526CNE2453, 061205CNE1718, 070510CNE2340, 111110HCC3126

go-seek,[22] climbing the dresser for challenge or to jump,[23] and sitting in lower drawers for fun.[24] Examples of purpose-based behaviors found in the data include: standing on a lower drawer to extend reach or to see into upper drawers,[25] using the dresser to pull to a standing position,[26] scaling a dresser to get into a nearby crib,[27] and opening drawers to remove clothing.[28]

Restraint system

None of the IDIs reviewed by ESHF staff reported that a tipover prevention system was installed on the incident clothing storage units; however, only a few IDIs specifically mentioned that a tipover prevention device was not installed. The remainder of incidents made no mention of tipover prevention devices and would, therefore, be more appropriately considered unknown.

Witnesses and other children

Although it was not possible to determine if the incident was witnessed in 23 (14%) cases, in 127 (80%) cases there was no adult present and the victim was either alone (44%) or with other young children (36%). Although ESHF staff did not analyze the room in which an incident took place, previous analyses have found that the 47 percent of tipover fatalities involving children occur in the bedroom (Suchy, 2014). Parents consider children's bedrooms to be the "safest" room because parents expect to leave a child in the environment alone to sleep (Garling & Garling, 1993; Peterson, et al., 1993). Therefore, it is both foreseeable and reasonable that a parent will leave a child unattended in a bedroom for the child to sleep, play, read, or watch television while a parent attends to other tasks, including sleep, in the house. A number of the incidents without an adult witness indicate the parent found the child after noticing the child was sleeping longer than typical. Several other incidents indicate that several children were watching television or playing together in one room while adults were tending to other activities in other rooms. This, too, is reasonable and foreseeable and is likely to become more common as children age.

NON-FATAL INCIDENTS

Although ESHF staff did not conduct a full review and analysis of non-fatal incidents, staff reviewed non-fatal incidents from CPSRMS to look for additional hazard patterns in near-miss scenarios that were unable to be identified from unwitnessed fatal incidents. For example, while there was no indication that consumers used tipover prevention

[22] e.*g.*, 080627HCC1694, 140507HCC1604
[23] e.*g.*, 010711HCN0741, 130328HCC2534
[24] e.*g.*, 140707HNE0001
[25] e.*g.*, 001214HCC0159, 010406HNE6277, 010913HEP9003, 070823HCC2740, 070612HNE2462, 080414HCC1531, 090304HCC1464, 110414HCC3640, 111130HCC3184, 150731HFE0001
[26] e.*g.*, 090514HCC1711
[27] e.*g.*, 031028HCN0081
[28] e.*g.*, 090812HCC3862

restraints in the fatality data, ESHF staff reviewed five non-fatal IDIs[29] involving tipover prevention restraints that were installed and failed. In addition, because opening multiple drawers at one time is often necessary when searching for items, moving items from one drawer to another, or placing clean laundry into a dresser, ESHF staff looked for incidents that involved multiple drawers open during typical use scenarios. Six IDIs[30] described scenarios where a clothing storage unit tipped over when multiple drawers with items in them were open with no other activity such as climbing. Two examples of multiple drawer incident scenarios are shown below:

> A 5-YEAR-OLD MALE OPENED THE BOTTOM THREE DRAWERS FROM A 5 DRAWER DRESSER AND IT IMMEDIATELY FELL FORWARD TO THE FLOOR. FORTUNATELY, THE CHILD WAS STANDING TO THE SIDE OF THE DRESSER WHEN IT FELL SO HE WAS NOT INJURED IN THE INCIDENT. (050726CNE2655)

> A 4-DRAWER CHEST TIPPED OVER WHEN A 2-YEAR-OLD GIRL OPENED THREE OF THE CHEST'S DRAWERS. THE CHILD'S MOTHER WAS IN THE ROOM AT THE TIME AND SHE CAUGHT THE CHEST BEFORE IT FELL ON THE CHILD. (150827CBB1866)

CONCLUSIONS

The review of fatal incident data discussed above indicates that it is foreseeable and developmentally expected for children under 6 years of age to interact with clothing storage units to dress themselves, place and remove items on top, and exercise developing problem-solving skills by stepping on lower dresser drawers in order to reach items in upper drawers and on top of a dresser. In addition, although clothing storage furniture is not intended to support climbing, it is also developmentally expected for children to use furniture for pretend play. Although there were no fatal IDIs that indicated a tipover prevention device was installed, a review of non-fatal CPSRSM incident suggests that some consumers install tipover restraints and still might experience a tipover event, and that tipover events have occurred during typical use of a dresser, such as opening multiple drawers. Therefore, ESHF staff concludes that the following use patterns should be considered when making revisions to the voluntary standard:

- A child under age 6 and weighing up to 60 lb climbing on a clothing storage unit to play.
- A child under age 6 and weighing up to 60 lb standing on a lower drawer in order to reach into an upper drawer.
- A consumer of any age simultaneously opening multiple drawers that contain items typically stored in a dresser.

[29] 050215CCN0439, 140917CBB1952, 100907CCC3092, 140917CBB2894, 140305CCC1448
[30] 050726CNE2655, 121114CNE0004, 131107CCC3126, 150827CBB1866, 140804CBB1817, 141027CBB3065

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TAB E

HUMAN FACTORS STAFF ESTIMATE OF WEIGHT IN SUPPORT OF FURNITURE TIPOVER ACTIVITIES

UNITED STATES
CONSUMER PRODUCT SAFETY COMMISSION
BETHESDA, MD 20814

MEMORANDUM

DATE: September 23, 2016

TO: John F. Massale, Mechanical Engineer,
Division of Mechanical Engineering, Directorate for Laboratory Sciences

THROUGH: Joel Recht, Ph.D, Associate Executive Director,
Directorate for Engineering Sciences

FROM: Timothy P. Smith, Senior Human Factors Engineer,
Division of Human Factors, Directorate for Engineering Sciences

SUBJECT: Human Factors Staff Estimate of Weight in Support of Furniture Tipover Activities

BACKGROUND

Staff of the U.S. Consumer Product Safety Commission (CPSC) currently is engaged in voluntary-standard and other activities pertaining to furniture tipovers. For example, staff of CPSC's Directorate for Laboratory Sciences, Division of Mechanical Engineering (LSM), is working on proposed revisions to ASTM F2057, *Standard Safety Specification for Clothing Storage Units*, to reduce the likelihood of tipover incidents with products that meet the standard. In support of these activities, LSM staff is seeking estimates from staff of CPSC's Directorate for Engineering Sciences, Division of Human Factors (ESHF), on the 95th percentile weight of 5-year-old children as a group, and if possible, separated by sex.

ASSESSMENT

BODYWEIGHT

To estimate bodyweight, ESHF staff primarily relies on data from the 2000 Centers for Disease Control and Prevention (CDC) growth charts, which were developed with data collected by the National Center for Health Statistics (NCHS) in five cross-sectional, nationally representative health examination surveys. Kuczmarski and colleagues (2002) report the observed data for 5-year-olds in half-year intervals, by sex. Thus, although observed data are not available for 5-year-olds as a whole, data are available on the 95th percentile weight for males and females aged 5.5 to 5.99 years. These data are as follows:

	95th percentile weight, 5.5 – 5.99 years	
Sex	kg	lb
Males	25.85	57.0
Females	28.10	61.9

To construct their growth charts, CDC applied statistical curve smoothing procedures to the observed data. This procedure resulted in the following smoothed 95th percentile weights for children just younger than 6 years (71 to 71.99 months old):

	Smoothed 95th percentile weight, 71 – 71.99 months	
Sex	kg	lb
Males	26.7	58.8
Females	27.1	59.6

More recent, but incomplete weight data reported by the CDC suggest that current 5-year-olds may be heavier than the weights reported above. For example, Fryar and colleagues (2012) report the 95th percentile weight for 5-year-old males to be greater than 68 pounds (31.0 kg, or 68.4 lb). Thus, based on the best available information and anthropometric data, ESHF staff concludes that the 95th percentile weight of 5-year-old children is likely to be about 60 pounds (27.2 kg) or greater, with the heaviest females weighing slightly more than the heaviest males.

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TAB F

LSM TESTING PROTOCOL FOR CLOTHING STORAGE UNITS

Clothing Storage Unit Stability Performance Testing Standard Operating Procedure

June 1, 2016

Scope

This test procedure is intended to serve as a stand-alone testing document used to test clothing storage units for compliance with safety specifications and standards including stability testing requirements in ASTM F2057-09, ASTM. F2057-14, and other related standards and performance criteria determined by CPSC technical staff based on known product hazard data.

This test procedure is intended as a guide for U.S. Consumer Product Safety Commission staff to use for testing the stability of clothing storage units. This test procedure is not a mandatory or a voluntary standard though it uses some specific test methods and criteria from existing standards. Specifically, it takes existing test methods from the current voluntary standard for clothing storage units (ASTM F2057-14 *Standard Safety Specification for Clothing Storage Units*) and adds overburden testing (i.e., progressive testing to see at what weight the CSU tipped) and CG determination.

Failures to meet the ASTM voluntary standard will be photographed (if possible) and documented in a Product Safety Assessment report for the Office of Compliance.

Standards

At the time of this draft the following voluntary standards are applicable to clothing storage units.

ASTM International. (2014). *Standard Safety Specification for Clothing Storage Units. Designation: F2057-14.* West Conshohocken, PA: ASTM International.

1.0 REQUIRED TOOLING

1.1 These are the required tools needed to accurately complete the evaluation of Clothing Storage Units. Appropriate substitutions can be made.

- Chalk pencils or other non-permanent marking device
- Four Digital Scales w/ Electronic Display, accurate to the tenth of a pound
- Chattillon Compression Gauge with digital readout
- Lightweight Clamps
- Vertical Laser Line or any projectable gravity assisted vertical indicator
- Digital Inclinometer
- Gaffer's Tape or equivalent
- Camera
- 50 lb test mass saddle fixture
- Tape measure

2.0 TERMINOLOGY

- CG_x - The distance measured from the outside of the front right corner[31] of the unit to the center of gravity along the x-axis (front width).
- CG_y - The distance measured from the f outside of the front right corner of the unit to the center of gravity along the y-axis (side depth).
- CG_z - The distance measured from the floor surface to the center of gravity along the z-axis (side height).
- Width (x) – Widest length of the front face of the unit.
- Depth(y) – Deepest distance from the front face to the rear face of the unit.
- Height (z) – Highest point on the top face of the unit from the floor surface.

3.0 MATERIAL DETERMINATION

3.1 Record Sample Number
3.2 Record Make, Model, and Manufacturer
3.3 Visually determine the material composition of the front face, chassis (sides or framework), and backing as "particle board," "solid wood," "dense solid wood," or "other," used on the clothing storage unit.
3.4 Record results

[31] The "front right corner" is defined from the perspective of the unit. The "front right corner" is the front left corner from the perspective of a user viewing the front face of the unit. See Figure 1 for diagram.

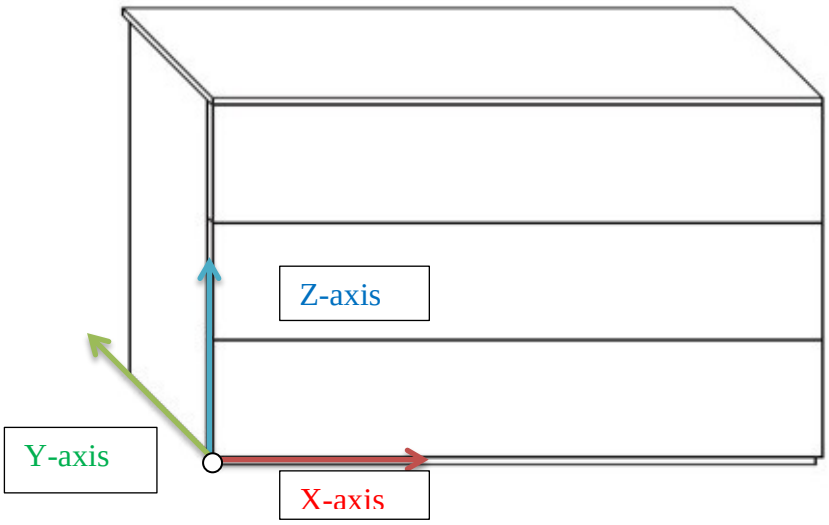

Figure 5: Coordinate system for measuring clothing storage units. All measurements references to the center of gravity are made from the outside of the front right corner[1] of the unit.

4.0 DIMENSIONAL MEASUREMENTS

4.1 Take pictures of the unit.

4.2 With the unit empty and all drawers and doors in the closed position, use a measuring tape to measure to the nearest ¼ inch the side to side (left to right) width (X), to the outer most points of the clothing storage unit.

4.3 Using a measuring tape measure, measure the front to back depth (Y) to the outer most points of the clothing storage unit.

4.4 Using a measuring tape measure, measure the floor to the top most surface height (Z) of the clothing storage unit.

4.5 With the drawers closed, and using the corner scales, place each corner of the clothing storage unit on the appropriate scale (left front, right front, etc.).

4.6 Record the total weight (W) in lb, as well as the weight at each corner of the storage unit.

4.7 Compute the percentage of weight on the front and rear faces, as well as the left and right sides.

4.8 Measure the farthest drawer extension, FDE, of each drawer, and note any differences. This value is the displacement of the front face of a drawer from its fully closed position to its maximum extension.

4.8.1 Calculate and record 2/3rds of the FDE

4.9 Remove from scales.

5.0 CENTER OF GRAVITY MEASUREMENT

5.1 DRAWERS FULLY CLOSED[32]

5.1.1 $CG_{side\ face}$

5.1.1.1 With the help of an assistant fasten an inclinometer to the unit, tip the dresser towards its front face until it reaches its most unstable point and record the angle of the inclinometer. Gaffer's tape or a suitable alternative can be used to ensure that the drawers stay closed.

5.1.1.2 With a vertical laser line, project a vertical line onto the side face of the unit, originating from the point where the storage unit is still contacting the ground.

5.1.1.3 Trace the projection using a chalk pencil, onto the storage unit and mark this line.

5.1.1.4 Repeat this process with the storage unit leaning backwards and mark where these two lines intersect.

5.1.2 $CG_{rear\ face}$

5.1.2.1 With the help of an assistant fasten an inclinometer to the unit, tip the dresser towards its side face until it reaches its most unstable point and record the angle of the inclinometer. Masking tape or a suitable alternative can be used to ensure that the drawers stay closed.

5.1.2.2 With a vertical laser line, project a vertical line onto the rear face of the unit, originating from the point where the storage unit is still contacting the ground.

5.1.2.3 Trace the projection using a chalk pencil, onto the storage unit and mark this line.

5.1.2.4 Repeat this process with the storage unit leaning in the opposite direction and mark where these two lines intersect.

5.1.3 Record the x, y, and z of the points from the front right corner as CG_x, CG_y, and CG_z, for the storage unit.

5.2 DRAWERS FULLY OPEN[33]

5.2.1 Open the top half row of drawers, rounded up, to their full extension and secure using clamps (i.e. if the unit has 7 rows secure the top 4 rows at full extension).

[32] This method, 5.1, will produce two measurements for CG_z. If the readings produce a discrepancy greater than 1 inch, repeat sections 5.1. Otherwise record the average of the two readings.

[33] This method, 5.2, will produce two measurements for CG_z. If the readings produce a discrepancy greater than 1 inch, repeat sections 5.2. Otherwise record the average of the two readings.

5.2.2 $CG_{SIDE\ FACE\ (OPEN)}$

5.2.2.1 With an assistant and an inclinometer, tip the dresser towards its front face until it reaches its most unstable point and record the angle of the inclinometer.[34]

5.2.2.2 With a vertical laser line, project a vertical line onto the side face of the unit, originating where the storage unit still contacts the ground.

5.2.2.3 Trace the projection using a chalk pencil onto the storage unit

5.2.2.4 Repeat this process with the storage unit leaning backwards and mark where these two lines intersect.

5.2.3 $CG_{REAR\ FACE\ (OPEN)}$

5.2.3.1 With an assistant and an inclinometer, tip the dresser towards its side face until it reaches its most unstable point and record the angle of the inclinometer.

5.2.3.2 With a vertical laser line, project a vertical line onto the rear face of the unit, originating where the storage unit still contacts the ground.

5.2.3.3 Trace the projection using a chalk pencil onto the storage unit

5.2.3.4 Repeat this process with the storage unit leaning in the other direction and mark where these two lines intersect.

5.2.4 Record the x, y, and z of the points from the front right corner as CG_x, CG_y, and CG_z, for the storage unit.

6.0 RESTRAINT TESTING PROVISION

6.1 If provided, assemble the tipover restraint components including fasteners in accordance with manufacturer's instructions.

6.2 Take pictures of the tip restraint device.

6.3 Rigidly suspend the assembly by securing one end of the restraint by gripping directly, or attaching to a fixed structure (for example, wooden block).

6.4 Attach a loading device to the fastener(s) on the opposite end of restraint.

6.5 Gradually, over a period of not less than 2 seconds but not greater than 15 seconds, apply the static load of 50 lb (23 kg) and maintain for an additional 30 seconds.

6.6 If the fastener(s) become unattached from the test structure (wood block or fixed structure) in such a way that it prohibits the completion of the test, then the fastener(s) are to be reattached using whatever means possible without affecting the test results of the assembly.

[34] If the unit begins to tip in this configuration without the aid of an investigator, the center of gravity is beyond the front legs and should be noted as such.

6.7 Record any additional notes

7.0 QUASI-STATIC STABILITY TESTING

7.1 DRAWERS AT 2/3[RDS] EXTENSION

7.1.1 STABILITY OF UNLOADED UNIT[35]:

7.1.1.1 Position the empty unit on a hard, level, flat surface.
7.1.1.2 The unit shall be level during testing unless specifically designed otherwise.
7.1.1.3 Open all doors to 90° and extend all drawers and pullout shelves, to 2⁄3 (66 %) of their operating travel. Do not affix clamps.
7.1.1.4 Open flaps or drop fronts to their horizontal position or as near horizontal as possible.
7.1.1.5 Record whether or not the unit tips over.

7.1.2 STABILITY WITH LOAD[36]:

7.1.2.1 Position the empty unit on a hard, level, flat surface. The unit shall be level during testing unless specifically designed otherwise.
7.1.2.2 ***Drawers*** **-** Open one drawer to 2⁄3 (66 %) of its operating travel. Do not affix clamps
7.1.2.3 All other drawers and doors not undergoing testing shall be in the closed position unless they must be opened to access other components behind them.
7.1.2.4 Gradually apply test weights over the front of each drawer.
7.1.2.5 For odd-shaped drawers, apply test weights to the front edge that protrudes the farthest.
7.1.2.6 Close the drawer and repeat this process on each drawer until all drawers have been tested.
7.1.2.7 ***Doors*** **-** Open one door to 90°.
7.1.2.8 All other doors and drawers not undergoing testing shall be in the closed position unless they must be opened to access other components behind them.
7.1.2.9 Apply test weights to each door so that the outer edge of the test weight is flush with the outermost upper corner of the door.
7.1.2.10 Close door and repeat with another door until all doors have been tested.

[35] This section matches ASTM F2057-09b section 4.1
[36] This section matches ASTM F2057-09b section 4.2

7.1.2.11 Record whether or not the unit tips over.

7.2 DRAWERS AT FULL EXTENSION

7.2.1 STABILITY OF UNLOADED UNIT[37]:

7.2.1.1 Position the empty unit on a hard, level, flat surface. The unit shall be level during testing unless specifically designed otherwise.
7.2.1.2 Open all doors to 90° and extend all drawers or pullout shelves, or both, to their maximum operating travel.
7.2.1.3 Open flaps or drop fronts to their horizontal position or as near horizontal as possible.
7.2.1.4 Record whether or not the unit tips over.

7.2.2 STABILITY WITH LOAD[38]:

7.2.2.1 Position the empty unit on a hard, level, flat surface.
7.2.2.2 ***Drawers*** **-** Starting with the top, open one drawer to its maximum travel.
7.2.2.3 All other drawers and doors not undergoing testing shall be in the closed position unless they must be opened to access other components behind them.
7.2.2.4 Gradually apply test weights over the front of each drawer.
7.2.2.5 For odd-shaped drawers, apply test weights to the front edge that protrudes the farthest.
7.2.2.6 Close the drawer and repeat this process on each drawer until all drawers have been tested
7.2.2.7 ***Doors*** **-** Open one door to 90°.
7.2.2.8 All other doors and drawers not undergoing testing shall be in the closed position unless they must be opened to access other components behind them.
7.2.2.9 Apply test weights to each door so that the outer edge of the test weight is flush with the outermost upper corner of the door.
7.2.2.10 Close door and repeat with another door until all doors have been tested.
7.2.2.11 Record whether or not the unit tips over.

[37] This section matches ASTM F2057-14 section 7.1
[38] This section matches ASTM F2057-14 section 7.2

7.3 ULTIMATE TIPOVER

7.3.1 VARIED FORCE, MAXIMUM DISTANCE

7.3.1.1 Position the empty unit on a hard, level, flat surface. Open the unit's top drawer that is ***closest in-line to CG_x***, to the drawer's maximum operating travel. Gradually apply load using the force gauge, in line with CGx, on the front edge of the drawer. For odd-shaped drawers, apply the force to the front edge that protrudes the farthest.

7.3.1.2 For doors, gradually apply force to the door, which opened to 90°, on the outermost upper corner of the door. Record how much force is required to tip the storage unit over.

7.3.2 VARIED DISTANCE, 50 LB MAXIMUM

7.3.2.1 Position the empty unit on a hard, level, flat surface. Open the units' top drawer that is ***closest in-line to CG_x***, and apply the 50lb (23kg.) saddle fixture.

7.3.2.2 Move the drawer as close as possible to its fully closed position.

7.3.2.3 Gradually open the unit's drawer, measuring displacement of the front face, from its fully closed position. Record the distance of the drawer at which the unit begins to tip. If the drawer reaches full extension and does not tip, record "no tip."