

# Damaged and Soiled Refrigerator Seals (Gaskets) from Commercial Food Premises: A Potential Reservoir for Food Pathogens

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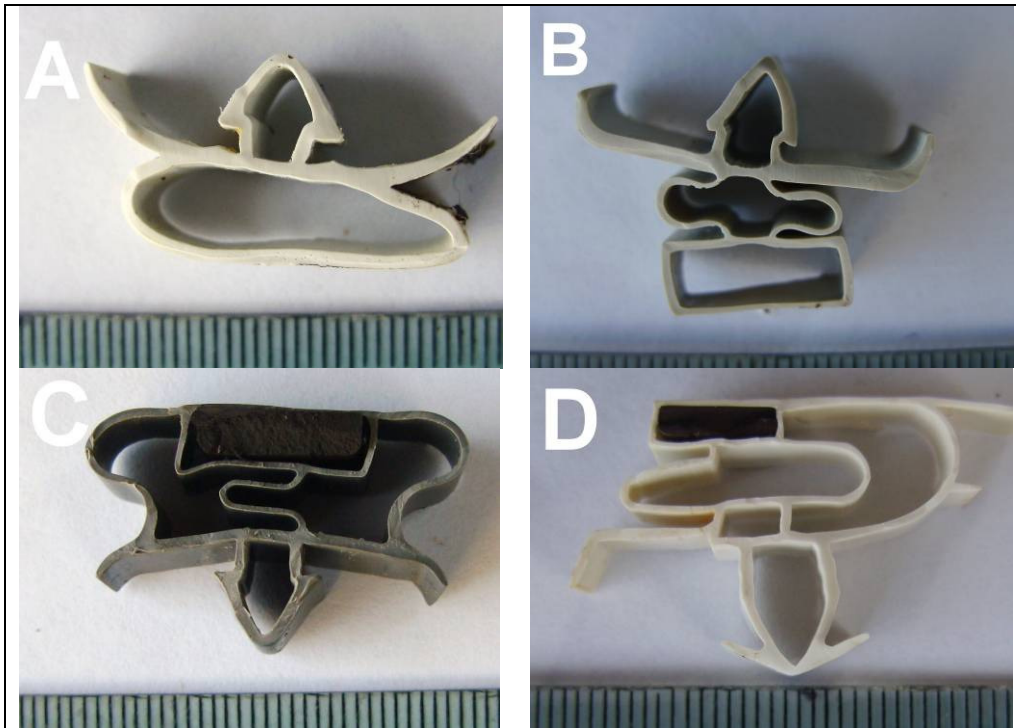
## ***Abstract***

Damaged and faulty refrigerator seals from eleven UK catering establishments were collected and examined for surface cleanliness and materials that may have collected within the damaged areas. The state of cleanliness of these seals were described using the terms 'heavily soiled', 'soiled', 'stained' and 'lightly stained', 'fairly clean' and 'clean'. Based on this information, an overall assessment was made of the general state of cleanliness found in these worn seals. Of the 15 samples studied, 3 were categorised as 'very poor', 5 as 'poor' and 7 with the highest rating that could only be described as 'fair'. The implication of these findings for food safety is discussed.

## ***Introduction***

Refrigeration prevents the growth of food spoilage organisms and slows or even stops the growth of many food-borne pathogens<sup>1</sup>. To maintain the correct storage temperatures within the refrigeration cabinet/cold store it is essential to maintain an airtight seal between the refrigerated space and the surrounding ambient temperature. Early refrigerators used a gasket where tight closure was obtained by applying pressure via a door catch device. Although still in use today, this method of sealing the door has been largely superseded by the use of magnetic door seals. The first patents were issued in the early 1950's but by the 1960's the modern-day system using rubberized magnets held in an extruded plastic seal of a bellows design was established<sup>2</sup>. This design ensures that the seal can accommodate any distortion in the door closure assembly. The rears of the seals are slotted into the door using an anchor shaped extrusion that is concealed by one or more flanges (Figure 1).

The design of the magnetic seals means that their external surface is complex with many folds and flanges in which dirt and food can accumulate. Repeated opening and closing of the doors combined with the effect of cleaning of the seals, places them under stress and splits and cracks can occur in the folds and joints (Figure 2). This is particularly relevant to food hygiene as any food and dirt entering any splits will accumulate undetected. This region has a potential to become a hidden reservoir of microorganisms, including food pathogens. If this occurs, then the opening and closing of the doors will force the air in and out of the chambers through the split with the potential of forming aerosols of microorganisms. These might then be circulated

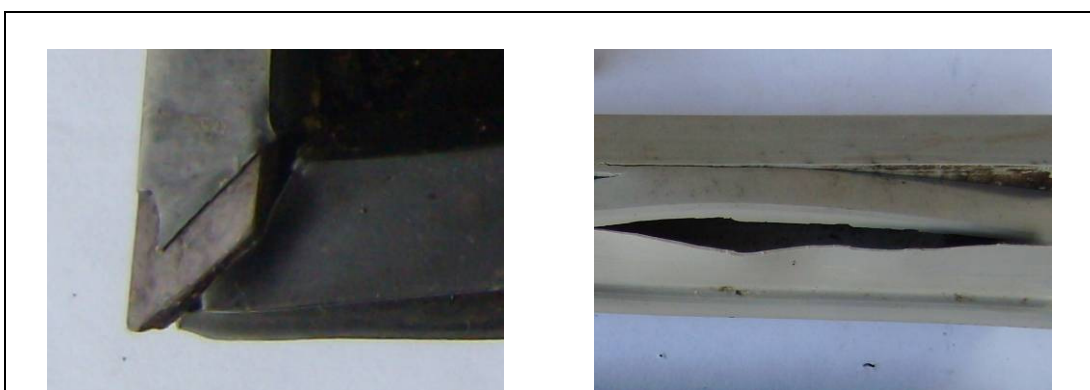


**Figure 1: Typical cross sections of refrigerator door seals**

(A) Compression seal; (B) Single chambered magnetic seal with rear double flange; (C) Double Chambered Magnetic seal with rear double flange; (D) Multi-Chambered Magnetic seal with single rear flange and side flanges. Rule marks (1mm) are shown.

inside the refrigerator and around the food preparation areas.

Under the taxing conditions found in commercial food premises, these seals need to be replaced every 6-18 months. Studying the state of these seals at time of replacement provides a unique opportunity to explore the effectiveness of their cleaning and to look for the accumulation of material in the interior chambers.



**Figure 2: Examples of torn and broken fridge seals**

## **Materials and Methods**

A refrigerator maintenance company provided samples of damaged seals collected by a single technician from UK commercial food premises during Monday 11th and Friday 15th July 2011. The seals were selected for replacement because of customer requests arising either from their own in-house audit or because of an Environmental Health Organization inspection. From each premises, samples of old seals were selected, bagged in a paper envelop and shipped for a preliminary visual examination. This examination was conducted on the 21st and 22nd July 2011.

### **Seal Backs**



'heavily soiled'



'soiled'

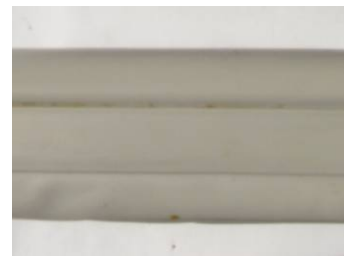
### **Seal Fronts**



'soiled'



'stained'



'fairly clean'

### **Seal Interiors**



'oily particulates'



fungal mycelium?



'particulates'

**Figure 3: Examples of Classification used in Table 1**

Samples were examined and classified for state of cleanliness then photographed as described in the Methods Section.

In all, 15 samples of refrigerator seals were obtained from 11 food premises. Samples usually consisted of sections cut from the lower corners and straight sections from intact and damaged areas. The front and back of each sample was then visually examined and photographed with a digital camera (Hewlett-Packard HP Photosmart

Mz60). The damaged areas were then examined, the split sections opened and the interior examined and photographed. For comparison the interior state of sections from undamaged areas were also examined. The state of cleanliness of these seals were described using the terms ‘heavily soiled’, ‘soiled’, ‘stained’ and ‘lightly stained’, ‘fairly clean’ and ‘clean’. The presence of any particulates, obvious fungal growth and liquid was also noted. Examples of these classifications are shown in figure 3.

Sample Number	Exterior Front	Exterior Back	Interior	Overall Cleanliness Assessment
1	Heavily Soiled.	Heavily Soiled	Heavily Stained	Very Poor
2	Lightly Soiled	Soiled	Stained	Fair
3	Stained	Soiled	Particulates	Poor
4	Heavily Stained	Heavily Soiled	Stained	Very Poor
5	Heavily Stained	Stained	Stained	Poor
6	Fairly Clean	Stained	Light Stain, Particulates, Oily	Fair
7	Fairly Clean	Light Stains	Fairly Clean	Fair
8	Light Stain	Light Stain, Particulates	Light Stain, Mycelium?	Fair
9	Fairly Clean	Stain	Particulates	Fair
10	Light Stain	Highly Soiled	Heavily Soiled	Very Poor
11	Fairly Clean	Oily, Soiled	Particulates	Fair
12	Stained	Soiled	Fairly Clean	Poor
13	Stained	Stained	Particulates	Poor
14	Fairly Clean	Stained	Particulates	Fair
15	Stained	Soiled	Oily Particulates	Poor

**Table 1: Cleanliness Assessment of Damaged Fridge Seals**

Samples of 15 fridge seals collected and their state of cleanliness evaluated as described in the materials and methods section. Based on this data, the overall cleanliness of the fridge seals at time of replacement was assessed.

## **Results**

The findings of this study are summarized in Table 1. As would be expected from the use of paper bags to store the samples, most of the materials were dry. Any liquid found was described as being of an oily nature. The readily visible front surfaces were most likely to be given the highest ranking in terms of cleanliness. Even here, however, the term ‘clean’ could not be used because even in the best cases there were signs of staining, particularly in any surface ridges. The backs of the seals, which are hidden from view, were generally in a poorer state of cleanliness. The interiors near

splits and corners showed an accumulation of particulate materials. Some appeared to be particles of food, or crystalline substances consistent with the drying of sugary liquids. Based on this information, an overall assessment was made of the general state of cleanliness found in these worn seals. Of the 15 samples studied, 3 were categorised as 'very poor', 5 as 'poor' and 7 with the highest rating that could only be described as 'fair' (Table 1).

## **Discussion**

In the United States alone, it has been estimated that food-borne diseases cause approximately 76 million illnesses, 325,000 hospitalizations, and 5,000 deaths each year<sup>3</sup>. The improper cleaning of food equipment has been attributed to 6% of such diseases<sup>4</sup>. Although the author is not aware of a specific study of commercial premises, poor hygiene was attributed to the isolation of a number of undesirable food related pathogens, i.e. *Listeria monocytogenes*, *Yersinia enterocolitica* and *Staphylococcus aureus* from a small but significant percentage of domestic refrigerators<sup>5</sup>. The poor hygiene noted in this study suggested that these findings are very likely to apply to commercial fridges as well, but with even wider consequences to public health. Infection by these organisms is very unpleasant and can even be deadly. *L. monocytogenes* causes generalized infection symptoms (fever, chills, malaise, prostration, aches, and swollen lymph nodes). *Y. enterocolitica* causes lower gastrointestinal tract symptoms (abdominal cramps, diarrhoea) mimicking flu and acute appendicitis. *S. aureus* and its enterotoxins cause nausea, vomiting, retching, diarrhoea, abdominal pain and prostration<sup>6</sup>. *L. monocytogenes* itself is a particularly dangerous food pathogen with the ability to grow even at refrigerator temperatures<sup>7</sup> and responsible for 28% of the food poisoning deaths in the USA<sup>3</sup>.

Cleaning is the first line of defence against food-borne illness. The spaces between close-fitting metal-to-metal or metal-to-plastic parts, worn or cracked and damaged rubber seals around doors, are all well-known environmental niches for microorganisms<sup>8</sup>. The designs of fridge seals are such that they contain many examples of such spaces and crevices for such niches. The importance of hygiene is well recognized and the UK the food standards agency. They have previously issued particular advice to commercial catering business owners to 'pay special attention to cleaning air intakes, air outlets, the fins or grills of evaporators, defrost water drainage channels and door seals'<sup>9</sup>. In the UK, the current practice is for food catering businesses to set up their own food safety management procedures based on the principles of HACCP (hazard analysis critical control point)<sup>4, 10</sup>. With this approach, the authorities do not issue any specific guidelines instead, management are expected to develop their own protocols. The results of this study suggest that for 8 of the 15 samples, dirty and worn refrigerator seals were not identified as potential hazards.

Combining the known correlation of poor hygiene with food-borne diseases, the question is not whether poorly cleaned and damaged fridge seals contribute to these diseases, but to what extent. Even more worrying for public health is whether these findings reflect a more widespread lack of attention to equipment cleaning and maintenance in catering establishments.

## **Conclusion**

The poor cleanliness of 8 out of 15 refrigerator seals removed from 11 UK food-catering establishments over a single week must raise concerns for food-safety. Although the complex design of the seals does make their cleaning difficult, the finding of readily visible surface soiling indicates that certain establishments have an extremely poor level of hygiene. It was also evident that any breaks or tears in these seals allow materials to accumulate so that even if the exteriors were clean, there would be areas that would provide hidden niches for microbes. This study points to the need for catering establishments to improve the inspection, cleaning and timely replacement of refrigerator seals. To this end, a regular schedule of seal removal, extensive cleaning of the revealed surfaces and replacement with new seals is recommended on at least an annual basis. Regulatory authorities may also need to re-emphasize areas requiring special attention in equipment maintenance and hygiene protocols.

## **References**

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- <sup>1</sup> United States Department of Agriculture Food Safety and Inspection Service. Refrigeration and Food Safety. [http://www.fsis.usda.gov/pdf/refrigeration\\_and\\_food\\_safety.pdf](http://www.fsis.usda.gov/pdf/refrigeration_and_food_safety.pdf)
  - <sup>2</sup> W.C. Frehse. Gasket Assembly. 1966 US Patent number: 3378957
  - <sup>3</sup> Paul S. Mead, Laurence Slutsker, Vance Dietz, Linda F. McCaig, Joseph S. Bresee, Craig Shapiro, Patricia M. Griffin, and Robert V. Tauxe. Food-Related Illness and Death in the United States. *Emerging Infectious Diseases* 1999; 5; 607-625
  - <sup>4</sup> F. L. Bryan. Hazard analysis Critical control Point (HACCP) Systems for Retail food and Restaurant Operations. *J. Food Protection* 1990, 53; 978-983
  - <sup>5</sup> V. Jackson, I.S. Blair, D.A. McDowell, J. Kennedy, D.J. Bolton. The incidence of significant foodborne pathogens in domestic refrigerators. *Food Control* 2007; 18; 346-351
  - <sup>6</sup> Foodborne Pathogenic Microorganisms and Natural Toxins Handbook: Onset, Duration, and Symptoms of Foodborne Illness. FDA Publication 2009 <http://www.fda.gov/Food/FoodSafety/FoodborneIllness/FoodborneIllnessFoodbornePathogensNaturalToxins/BadBugBook/ucm071342.htm>
  - <sup>7</sup> T. Jemmi & R. Stephan. *Listeria monocytogenes* : food-borne pathogen and hygiene indicator. *Rev. sci. tech. Off. int. Epiz.*, 2006, 25 (2), 571-580
  - <sup>8</sup> R. B. TOMPKIN. Control of *Listeria monocytogenes* in the Food-Processing Environment. *Journal of Food Protection* 2002: 65; 709-725

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<sup>9</sup> Food Safety and Hygiene Working Group. Industry Guide to Good Hygiene Practice Food Safety (General Food Hygiene) Regulations: 1995 Food Safety (Temperature Control) Regulations 1995: 1997, ISBN 0 900 103 00 0

<sup>10</sup> Food hygiene – a guide for businesses. FSA Guide Booklet. Published by the Food Standards Agency February 2006, [www.food.gov.uk](http://www.food.gov.uk)