Safe Disposal Systems, Inc.

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November 29, 2009

Climate Action Reserve
523 W. 6th Street Suite 428
Los Angeles, CA 90014

Re: Comments US ODS Project Protocol

Dear Climate Action Reserve,

Thank you for you efforts in drafting the ODS protocol; It is evident the United States is lagging in preventing ODS emissions; I have great hopes for the voluntary system and the benefits this protocol will have.

I have one significant broad based comment and list of technical comments; I have organized my letter as such.

The Reserve states "The Reserve's high standards ensures that emission reductions associated with projects are real, permanent and additional…" I believe the Reserve hit its mark with regards to Refrigerant Sources but has missed when it comes to Foam Sources.

The quantity of ODS entrained in foams is significant and should be addressed with the same zeal the Reserve used for refrigerant sources. Processing foams offer great environmental benefit as so much of a foam project has additive benefit to the environment.

I believe the Reserve should address foam in a staged manner;

1. Allow foams recovered by any method to be destroyed for CRTs for 24 months.
2. Create a deadline for foam burning projects encouraging conversion to extraction methods.
3. Separate building foams vs. appliance foams as the blowing agents and recovery processes are different.

By allowing foams to be directly incinerated leaves too many unverifiable quantities (see technical comments) to label the protocol as a "high" standard. The short term additive benefits are undeniable but should not undermine the development of a foam processing industry in the United States. The Reserve should consider foam burning as an interim step to extraction. There are 27 plants in the world that extract ODS entrained in foam and Reserve should have a goal of supporting companies wishing to import or develop

the technology as the world has clearly demonstrated the efficiencies and quantities of ODS captured are significantly increased using these methods. The Reserve should support “Best available Technology” and encourage its adoption by all means at its disposal.

Encouraging manual disassembly or “filleting” and discouraging capture after shredding is inconsistent. The Oko-Institut e.V. (see attached) has commented on interim results on their study of manual disassembly showing the practice to average a 41% loss due to non treatment of the doors (the current practice in the US) and the PUR not recovered. This is significantly higher than the 24% average stated by the Sheutz study for appliance shredding; If the Reserve shifted its focus to improved verification as to the quantity of ODS at the destruction facility why would it matter how it was captured, transported, or treated prior to arrival? The market will dictate these practices as high expense for burning and low mass of the foam will reward those who can innovatively keep the ODS content high. All ODS destroyed in this matter is additive and the Reserve should encourage innovation rather than dictate terms of handling.

I encourage the Reserve to rework the Foam Sources language to focus on quantitative verifiability at the destruction facility and leave the process to market driven American ingenuity.

Sincerely;

Brian Conners
Safe Disposal Systems, Inc.

Attached;
Technical Comments
Letter from Oko-Institut e.V.
US Patent 6732416

Technical Comments

Section 2.3.2 Foam Sources – 1
Section 6.4 #1

This section is trying to dictate foam extraction methods. European "Fridge Plants" have to meet the WEEE directive of 90% recovery. Why does the Reserve need to dictate on the method; Typical plants shred under vacuum but extract under pressure. The section isn't clear. It would seem setting a performance standard and certify the plant as the WEEE does would be a better approach. Example "ODS extraction methods must meet 90% efficiency rating as verified by a third party testing"

Section 2.3.2 Foam Sources - 2

The protocol doesn't define "container". Is there a size limit? A pressure limit?; a durability expectation? A sealing method? Airtight doesn't convey an expectation of performance. 2 mil thickness of what material? The waste industry has dumpster liners that are 30 feet x 8 feet x 10 feet; These could be hermetically sealed; saturated with water and load would only have two samples taken as written; This isn't statistically representative of the load.

Additionally; bagging foam for destruction is covered under patent 6732416 (attached) It may be problematic to encourage such activity.

Section 5.2.2 Project Emissions from Foam Separation
Section 6.4 Foam Collection and Management Requirements

This section references the TEAP report; In that report the manual disassembly loss was estimated as 10% to 15% but not quantitatively studied. The Oko-Institut e.V. report takes into account that the doors aren't processed and the foam not captured from the carcass. I support foam burning short term but there is no scientific data that supports manual disassembly can achieve a 90% RDE when accounting for the doors and foam not extracted. The Reserve should consider focusing on what gets destroyed and not what's released in the process as any destruction of ODS foam is additive to the current practices of landfill. The market will dictate that companies manage the foam to preserve the ODS content.

Section 6.4 Foam Collection and Management Requirements #2

The protocol is attempting to dictate a size of the foam pieces and a ratio of big to small; this is not verifiable unless measured and therefore I suggest the committee consider a different approach;

The foam should be segregated into three separate sized categories by mechanical means. Large, medium and small; The committee has shown reliance on the Scheutz study and it appears there is evidence that size is directly proportional to ODS content. If the committee reworked the foam handling requirements to segregate by size and randomly sample on a weight basis of a sized or weight limited container meeting a certain standard the protocol would better approximate the ODS content;

Oversights in 6.4

1. **No method for random sampling**
2. **No sample rate per lb of foam destroyed**
3. **No container size limits**
4. **No mention of container material (Polyethylene will allow refrigerants to diffuse out over time)**
5. **No mention of water content (The system is open to gaming.)**
6. **Containers should be "see through" for verification purposes.**
7. **Do the containers have to survive dumping on the tipping floor of a typical foam burning facility?**
8. **Can the containers be punctured prior to entry to furnace;**
9. **What is considered entry to the furnace? (tipping floor, pit feed)**
10. **If the verifier has to sample the container is their a requirement sample from the top, middle or bottom of the container?**
11. **Should the container be cored to obtain a better representative sample of the contents?**

Section 6.5 ODS Composition and Quantity Analysis Requirements

Why has the committee required a non DOT sample cylinder that cannot be transported to the laboratory via commercial means? The refrigerant industry has DOT39 one time use sample cylinders and reusable DOT sample cylinders.

The protocol refers to ARI700-2006 as the verification method for High Boiling Residue; This protocol is reported by volume not by mass; While the Reserves protocol requires mass it is not typical for labs to report by mass. The Reserve protocol should clearly call out to except the ARI700 procedure to HBR as it's a volume procedure using volumetric apparatus. The protocol should state its own procedure for determining HBR for clarity and uniformity.

Section 6.5.2 Analysis of Mixed ODS

The protocol has quoted many studies to back up its claims. Is there a study showing that four gases considered for this protocol could be mixed in such a matter that would reward

the project with excess credits? Our experience has been mixtures reach equilibrium and can be verified by obtaining a liquid sample and vapor sample. The need for mixing seems cumbersome and accomplishes very little. It opens the destruction facility to hose losses; catastrophic losses due to failure; and injury potential.

6.5.2 -1 “no interior obstructions” How would a verifier obtain this information and how would it effect results? Baffles are safety items for transportation.

6.5.2 – 4 “sampling ports both at the bottom and top” Is the protocol suggesting that containers with ports that sample the vapor space of the container are not sufficient? The port must be physically located on the top?

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29 October 2009

Interim results from tests of the manual disassembly of waste refrigeration appliances

Dear Mr Becker,

Öko-Institut e.V. is currently undertaking a study of the various disposal and treatment channels for waste refrigeration appliances. The complete study should be available by the end of November.
We can, however, already provide the following data that relate to one aspect of the study:

In September 2009, a series of tests were conducted that aimed to determine the levels of CFC emissions when waste refrigeration appliances are disassembled by hand. In order to establish a CFC-emissions dataset that could be used for comparative purposes, the manual disassembly techniques used were copied from the methods employed at waste fridge processing facilities in North and South America.

The tests demonstrated that manual disassembly leads to emissions of CFCs from the following three channels:

a) Cutting up the appliances with a saw
b) Manual removal/extraction of the foams from the appliance carcass (due to rupturing and opening of the cells in the foam polymer and outgassing of CFCs)
c) Residual quantities of insulating foam still adhering to metal and plastic.

The losses from channels a) and b) were estimated by weighing the intact appliances prior to disassembly and then weighing the material fractions after manual disassembly. It was assumed that the difference in weight is due to CFC losses to the environment. For the purposes of calculation, it was also assumed that in all the appliances tested, the average percentage weight of CFCs originally present in the polyurethane (PU) insulating foam was 8.5 %.

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The losses from channel c) were estimated by removing, collecting and weighing the residual PU foam that was found to be still adhering to parts of the appliance carcass after manual disassembly. The amount of CFC contained in this quantity of PU foam residue was then calculated. It seems reasonable to assume that the CFCs contained in any PU foam residues still adhering to carcass components will be completely released when these metal and plastic components are subsequently fed into a shredder.

Analysis of nine tests conducted on appliances of varying size show that these three emission channels alone account for losses of between 25 and 245 grams of CFC per appliance (mean average loss: approx. 99 g per appliance) As the appliances used in testing were of different size, it is more useful to consider the percentage rather than the absolute values. Relative to the amount of CFC originally present in the untreated appliance, manual disassembly resulted in losses of between 16 and 30 % by weight (mean average: 21 % of the mass of CFC originally present).

The following CFC losses were found for appliance carcasses (without the door):
absolute values: 15–233 g; average: 88 g.
percentage values 5–33 % ; average: 21 %.

The following CFC losses were determined for the doors:
absolute values: 1–17 g; average: 11 g.
percentage values 6–28 %; average: 20 %.

Additional CFC emissions might also arise at existing fridge treatment plants if the appliance doors, which contain PU foam insulation, are not disassembled to remove the foam. It is known that the disassembly of the door is a much more time-consuming and therefore cost-intensive process. In the appliances tested, around 14 % of the total PU foam in the appliance was contained in the doors.

For a number of appliances, we also estimated how much CFC escapes when the PU output fraction is stored in open sacks. The sacks were weighed after 24 hours (in the case of seven appliances) and after 14 days (in the case of four appliances). It was assumed that the difference in weight was completely attributable to CFC outgassing. After storing for 24 hours, the average CFC loss was 2.4 % relative to the original amount of CFC in the appliance). A further 1.5 % was lost after a storage period of 14 days.

We hope that the above information will be of use to you.

Yours sincerely

Dr. Doris Schüler

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US006732416B1

(12) **United States Patent**
Jacobsen et al.

(10) **Patent No.: US 6,732,416 B1**
(45) **Date of Patent: May 11, 2004**

(54) **REFRIGERATOR RECYCLING METHOD AND SYSTEM**

(75) Inventors: **Terry Jacobsen**, Snohomish, WA (US); **Michael Dunham**, Lake Forest, CA (US)

(73) Assignee: **Jaco Environmental, Inc.**, Snohomish, WA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **10/080,153**

(22) Filed: **Feb. 19, 2002**

(51) **Int. Cl.**[7] **B23P 19/04**; B23P 17/04; B23P 21/00

(52) **U.S. Cl.** **29/403.3**; 29/403.1; 29/711

(58) **Field of Search** 29/403.3, 403.1, 29/403.4, 426.3, 426.5, 426.6, 711; 62/298, 149, 292

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,074,477 A * 12/1991 Welter et al. 241/18

* cited by examiner

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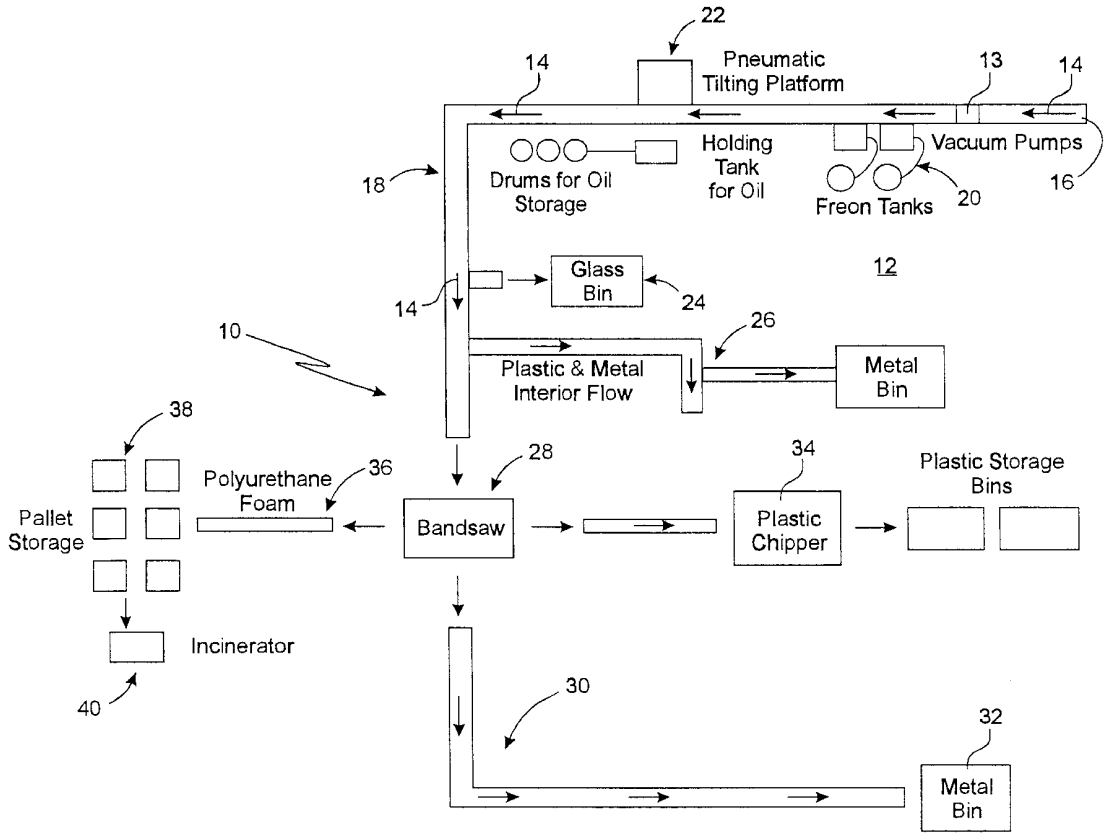
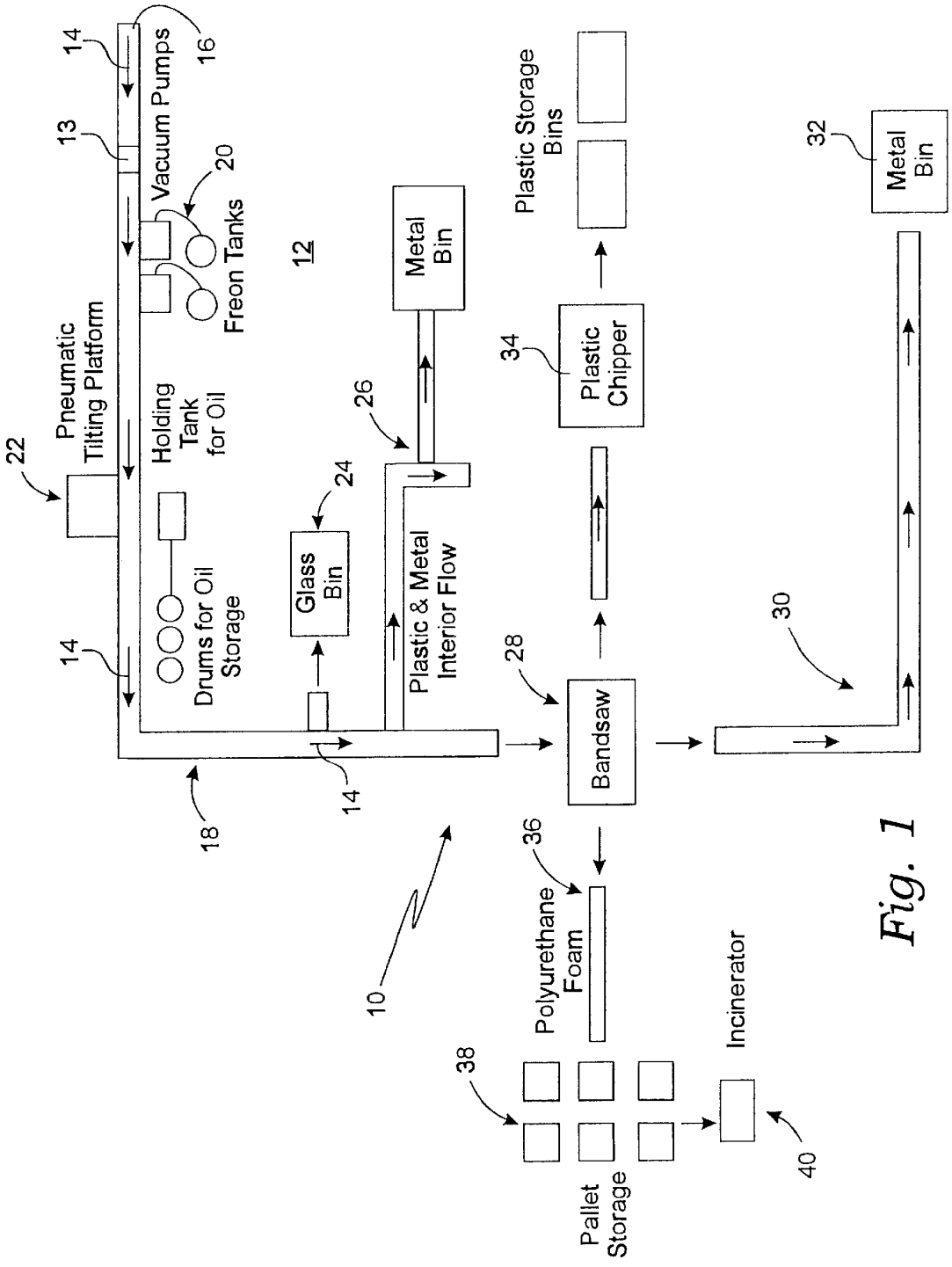
(57) **ABSTRACT**

A system and method for recycling materials from appliances, such as refrigerators and freezers, including a conveyor system having a number of stations to remove material from the appliance, and a band saw to cut the appliance into at least two pieces. The cut pieces of the appliance are taken apart to separate a metal shell and plastic interior from polyurethane foam. The polyurethane foam is placed in sealed bags, palletized, shrink-wrapped and shipped to an incinerator for burning to eliminate outgassing of CFC-11 to the atmosphere.

20 Claims, 1 Drawing Sheet

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16
Vacuum Pumps
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Freon Tanks
12
Metal Bin
Plastic Storage Bins
32
Metal Bin
Pneumatic Tilting Platform
Holding Tank for Oil
26
34
Plastic Chipper
22
24
Glass Bin
Plastic & Metal Interior Flow
Drums for Oil Storage
14
28
30
Bandsaw
14
18
36
Polyurethane Foam
10
Incinerator
38
Pallet Storage
40

Fig. 1

REFRIGERATOR RECYCLING METHOD AND SYSTEM

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention generally relates to recycling systems, and more particularly, to an improved and more efficient method and system for separating and recycling the materials in freezers and refrigerators.

2. Description of the Prior Art

It is well known that many household appliances, such as freezers and refrigerators, contain toxic materials that must be separated and removed and recycled or destroyed. Various techniques and processes have heretofore been employed in order to recycle portions of freezers and refrigerators. However, none of the known techniques or processes are successful in recycling or destroying R-11.

Large quantities of CFC-11 are stored in rigid cell foams, notably polyurethane foam or R-11 used for insulation of refrigerators, freezers and the like. The CFC-11 is used as a foam-blowing agent in the manufacture of polyurethane. The CFC-11 slowly outgasses from polyurethane, with an estimated half-life of 100–300 years and is a known contributor to ozone depletion. Heretofore, in an attempt to prevent the outgassing of CFC-11, the R-11 was pulverized. However, since the remaining CFC-11 in the R-11 is so strongly bonded to the foam, pulverization leaves two waste streams containing CFC-11 and pulverized foam with CFC-11 still attached. If sent to a landfill, this pulverized foam will eventually release the ozone depleting CFC-11 into the atmosphere as it decomposes. Therefore, the existing systems do not remove sufficient amounts of CFC-11 from R-11, nor are they applicable to a refrigerator and freezer recycling program.

The present invention provides improvements in destroying CFC-11 contained in R-11 and recycling and recovering other materials from refrigerators and freezers in an efficient and cost-effective manner. This is accomplished by utilizing a system that achieves a 90% material recovery rate and packages the R-11 for transport to an incinerator where it is destroyed. The refrigerators and/or freezers to be recycled are placed on a platform and the platform is loaded on a conveyor or roller transport system. The refrigerator or freezer is then moved through a plurality of stations in the system where various materials therein are removed or drained. The refrigerator or freezer is then placed horizontally on a platform and sent to a large band saw where the remaining housing is cut into a number of pieces to allow the metal shell and interior plastic pieces to be stripped away. The contaminated polyurethane foam is then removed and packaged for shipment to an incinerator for proper disposal of the R-11.

Therefore, it can be seen that the present invention meets an existing need in the art for an improved and more efficient method and system for eliminating CFC-11 held in R-11 and more effectively recycling appliances, such as refrigerators and freezers.

SUMMARY OF THE INVENTION

Accordingly, It is a general object of the present invention to provide an improved system for recycling appliances. It is a particular object of the present invention to provide an improved system for more efficiently recycling the materials in refrigerators or freezers. It is another particular object of the present invention to provide an improved method for removing polyurethane foam from refrigerators and freezers and packaging the foam for shipping to an incinerator. It is yet another particular object of the present invention to provide an improved method for achieving substantially improved recycling of approximately 90% of the materials utilized in a refrigerator or freezer.

These and other objects and advantages of the present invention are achieved by providing a method and system for recycling appliances comprising a conveyor system, a plurality of stations to remove material from the platform **13**, preferably in a vertical or upright position, and the holder or platform placed on the conveyor system **10** for movement in the direction of the arrows **14**. The conveyor, system **10** may be of any desired width, such as approximately two feet, to accommodate the platform **13** and refrigerator loaded thereon. The platform **13** is preferably about 2 feet square and may be of any desired thickness, such as approximately ½ inch thick plywood or plastic, so as to be easily carried along the system **10** as the refrigerator or other appliance thereon is moved through the system to remove and recover the materials therein.

The platform **13** and refrigerator are placed on the system **10** at a starting point or end **16** in a first portion or section **18**. The platform **13** and refrigerator or other appliance are moved to a first station **20** where refrigerant, such as freon, is evacuated from the refrigerator in any acceptable or known manner and pumped into tanks for shipping to a recycling/cleaning facility.

A compressor in the refrigerator or other appliance has a hole formed therein, as by drilling. The hole is of sufficient size to enable the compressor to be drained, and the platform **13** and refrigerator are moved to a second station **22** having a pneumatic tilting platform to tilt the platform **13** and refrigerator to an angle of approximately 20 degrees. A tube, or the like, is inserted in the drilled hole and the oil in the compressor pumped out into a holding tank and placed in EPA approved drums, preferably 55 gallon, for shipping to an environmental recycler.

Any capacitors or other devices containing PCB's are removed from the refrigerator or appliance and placed in UN/EPA approved containers for shipment to a waste incinerator.

Interior parts are removed from the refrigerator and sent to a glass bin at **24** or a plastic and metal interior flow conveyor portion **26** for appropriate storage and/or processing. The interior, parts removal may be done on the conveyor portion **18**, elevated from the supporting surface **12**, or the platform **13** and refrigerator thereon may be lowered to ground level for convenience.

After the interior parts are removed and the platform and refrigerator are at ground level, the refrigerator is moved so as to lay or rest horizontally on the platform **13**. The platform **13** and refrigerator are then moved to device **28**, such as a large band saw, to break or form the refrigerator into several pieces. The large band saw **28** is sized and dimensioned to enable a large refrigerator or freezer to be easily held therein and be cut into a plurality of pieces or sections. The band saw **28** includes a specifically designed set of pneumatic clamps for securely holding a refrigerator, or the like, during cutting. This clamping device also tilts the refrigerator to approximately 10° from horizontal to allow a saw blade in the band saw to more easily cut the refrigerator into pieces or sections. This tilting also preserves blade life.

The band saw **28** preferably cuts the refrigerator into 3 pieces by making 2 cuts spaced 18" to 24" from both the top and bottom of the refrigerator.

After being cut into 2 or more pieces or sections, each piece or section is taken apart, by machine or manually, by stripping away the metal shell and any interior plastic liner and pulling or scraping the polyurethane foam from the metal and/or plastic.

The metal is sent to a further portion or section **30** of the conveyor to system, where it may be compacted and then collected at **32**, for forwarding to a recycler.

The interior plastic liner, together with any other plastic taken from the interior is sent to a plastic chipper **34**, where it is shredded into manageable size pieces for sorting, storing, packaging and shipment to a plastic recycler.

The polyurethane foam is packaged at **36** into sealed plastic bags to prevent any further release of CFC-11. The sealed bags are then palletized and shrink wrapped for storage at **38** and eventual shipment to an approved incinerator **40** where the entire pallet and its contents are incinerated at 900° centigrade (Celsius) so that no harmful by-products are produced.

Those skilled in the art will appreciate that various adaptations and modifications of the just-described preferred embodiments may be configured without departing from the scope and spirit of the invention. Therefore, it is to be understood that, within the scope of the appended claims, the invention may be practiced other than is specifically described herein.

What is claimed is:

1. A method of recycling substantially all materials in an appliance, comprising the steps of:

placing the appliance on a platform in a facility at atmospheric pressure;

placing the platform and the appliance on and transporting the platform and the appliance along a conveyor system through a plurality of spaced stations, where various materials are removed from the appliance and stored for recycling; and

wherein the plurality of stations include a station to remove refrigerant, a station to remove oil, at least one station to remove interior parts, and a station having a band saw to saw the appliance into a plurality of pieces.

2. The method of claim **1**, including the further steps of stripping a metal shell and interior plastic from the plurality of pieces and removing polyurethane foam.

3. The method of claim **2**, including the further steps of placing the removed polyurethane foam into plastic bags, sealing the plastic bags against leakage of CFC-11, and incinerating the plastic bags and the polyurethane foam.

4. The method of claim **2**, including the further steps of placing the removed polyurethane foam in sealed plastic bags, placing a plurality of the sealed plastic bags of polyurethane foam on a pallet, and shrink wrapping the pallet and the plurality of the sealed plastic bags of polyurethane foam.

5. The method of claim **4**, including the further steps of transporting a plurality of shrink wrapped pallets and scaled plastic bags of polyurethane foam to an incinerator and incinerating each of the shrink wrapped pallets and sealed plastic bags at 900° C.

6. A process to recycle substantially all materials in a refrigerator or freezer, comprising the steps of:

placing the refrigerator or freezer on a platform in an upright or vertical position in a facility at atmospheric pressure;

placing the platform and the refrigerator or freezer on and transporting the platform and the refrigerator or freezer along a conveyor system to a plurality of stations;

removing any Freon from the refrigerator or freezer at a first station;

drilling a hole in a compressor in the refrigerator or freezer;

draining any oil from the compressor through the drilled hole at a second station by tilting the platform;

removing any capacitors from the refrigerator or freezer;

removing any interior parts from the refrigerator or freezer;

laying the refrigerator or freezer horizontally on the platform;

using a band saw to saw the refrigerator or freezer into at least two pieces at a further station; and

breaking the at least two pieces apart so as to separate any metal, plastic and polyurethane foam.

7. The process of claim **6**, including the further steps of placing the separated polyurethane foam in plastic bags, sealing the plastic bags to prevent the leakage of CFC-11, and incinerating the polyurethane foam and the plastic bags.

8. The process of claim **6**, including the further steps of placing the removed polyurethane foam in sealed plastic bags, placing a plurality of the sealed plastic bags of polyurethane foam on a pallet, and shrink-wrapping the pallet and the plurality of the sealed plastic bags of polyurethane foam.

9. The process of claim **8**, including the further steps of transporting a plurality of shrink-wrapped pallets and sealed plastic bags of polyurethane foam to an incinerator and incinerating each of the shrink-wrapped pallets and sealed plastic bags at 900° C.

10. The process of claim **9**, including the further steps of placing the removed Freon and drained oil into containers for shipment to recyclers.

11. The process of claim **9**, including the further steps of transporting the removed capacitors, removed interior parts, the separated metal and plastic to storage for further handling.

12. A system to recycle substantially all materials in an appliance, such as a refrigerator or freezer comprising:

a facility for receiving the appliance; the facility being at atmospheric pressure,

a platform for supporting the appliance in an upright or vertical position;

a conveyor system for transporting the platform and appliance in the facility;

a first station in the facility for removing any Freon from the appliance;

means in the facility for drilling a hole in a compressor in the appliance;

means in the facility for draining any oil from the compressor through the drilled hole and storing the oil for shipment;

means in the facility for removing any interior parts from the appliance and transporting to storage;

means in the facility for cutting the appliance into at least two pieces;

means in the facility for tearing the at least two pieces apart so as to separate any metal, plastic and polyurethane foam; and

means in the facility for transporting the separated metal, plastic and polyurethane foam to separate areas for further handling.

13. The system of claim **12**, further including means in the facility for placing the separated polyurethane foam in

plastic bags and sealing the plastic bags to prevent leakage of CFC-11 and incinerating the sealed plastic bags of polyurethane foam.

14. The system of claim **12**, further including shrink wrapping a plurality of the sealed plastic bags on a pallet and providing an incinerator for incinerating each pallet and plurality of the sealed plastic bags at 900° C.

15. The system of claim **12** wherein the means in the facility for cutting the appliance into at least two pieces is a band saw, sized and dimensioned to receive, hold and saw the appliance into at the least two pieces.

16. The system of claim **13** wherein the means in the facility for draining the oil from the compressor includes a tilting platform that tilts the platform and the appliance thereon.

17. The system of claim **16** wherein the tilting platform is movable approximately 20 degrees.

18. The system of claim **17**, further including means in the facility for placing the separated polyurethane foam in plastic bags to prevent leakage of CFC-11.

19. The system of claim **18**, further including means in the facility for placing a plurality of the scaled plastic bags on pallets and shrink-wrapping the pallets and the plurality of the sealed plastic bags for shipping.

20. The system of claim **15** wherein the band saw includes a set of pneumatic clamps for securely holding the appliance at an angle of approximately 10° from horizontal.

* * * * *