HPRC
Healthcare Plastics Recycling Council

Healthcare Plastics: Guidance for Recyclers

Contents

Introduction

Did you know that healthcare facilities in the United States generate approximately **14,000 tons of waste per day** and that up to 25% of that waste is plastic packaging and products?

Additionally, the vast majority of that plastic waste, up to 85% or more, is **non-infectious**. Overall, it is estimated that there are about 1 million tons of clean, non-infectious healthcare plastics generated in US healthcare facilities each year. While the potential of this largely untapped waste stream is obvious, how to access this waste stream can be less clear.

The Healthcare Plastics Recycling Council (HPRC) has prepared this guidance document to help inform and educate plastics recyclers and processors about the common streams of plastic waste generated in clinical settings. By laying out the common materials, strategies for working with hospitals, processing techniques, and potential markets, we aim to build the foundation for recycling activities across the healthcare industry.

This document is divided into the following sections:

- Information about healthcare plastics, including the most commonly generated healthcare plastic waste streams.
- How to partner with hospitals for a successful recycling program.
- Recycling options, including common steps in mechanically processing healthcare plastics.
- Case studies and other helpful resources.
- Technical specifications for common healthcare plastics.

The Healthcare Plastics Recycling Council is a private, technical coalition of industry peers across the healthcare, recycling, and waste management industries seeking to improve recyclability of plastic products within healthcare.

Our Members

Our Advisory Board

About Healthcare Plastics

In order to meet strict United States Food and Drug Administration (USFDA) requirements for medical supplies, equipment, and associated packaging, most healthcare plastics are pure, high-quality materials. By working with hospitals to help them produce clean streams of specific materials, plastics recyclers can gain a material source which can help improve the performance of their regrind and repro pellets, and products produced from these materials.

Besides the direct economic value of these materials, it is also important to consider the social and environmental value of recycling these materials. As the importance of sustainability continues to rise within the marketplace, manufacturers and major brand owners are increasingly looking for high-quality recycled content to utilize in the formulation of their products. This trend often supports commodity pricing that exceeds the base economic value, enabling recyclers to potentially capture a premium price for these materials.

What are the most common materials?

This section presents information on the most common healthcare plastics, based on HPRC research.

Sterilization Wrap

- Commonly referred to as 'blue wrap' within the healthcare industry (although it can come in a variety of other colors, including green, purple, and white), this polypropylene (PP) wrap is a clean material that protects surgical instruments and other items from contamination during and after sterilization. In its typical use within the healthcare setting, the material should never come into patient contact.
- Sterilization wrap is the highest-volume recyclable plastic material generated in healthcare settings, with about 5 million pounds of sterilization wrap recycled annually. However, according to the healthcare sustainability non-profit Practice Greenhealth, approximately 255 million pounds of sterilization wrap is sold to the healthcare industry annually.
- Sterilization wrap can easily be collected and recycled with other PP materials, and its MFI (melt flow index) is usually around 40. It is a non-woven material and processes exceptionally well on densification lines with continuous melt filtration. This material is in demand by PP compounders to raise the melt on their lower MFI polypropylene feed-streams (see Appendix 1 for technical specification).

Irrigation Bottles

- Irrigation bottles are commonly used in healthcare settings and are typically PP or high-density polyethylene (HDPE) with a PP cap. See Appendix 1 for a typical HDPE technical specification.
- The irrigation fluid in these bottles is a non-hazardous saline solution (water and salt).
- Label adhesives are commonly water-based.
- If there is any saline solution residue, these bottles are easy to drain and recycle with similar PP and PE materials.

Natural in color, HDPE bottles are best processed via grinding, washing, and melt filtering to remove paper labels.

Post-processing, high-density polyethylene is commonly used in irrigation pipes, trays, slip sheets, and railroad ties.

Pitchers, Basins, and Cups

- Containers such as pitchers, basins, and cups are used for patient care and are typically made from homo-polymer PP.
- These containers are easily collected within the hospital setting and may be recycled with similar PP materials.
- Most often found in white, grey, tan, pink, or blue colors, these containers are injection grade with a melt flow index of 12 to 30. This material can be used as a feedstock for compounders and injection molders for products ranging from parts to bins.

Pilot Studies

- HPRC partnered with Stanford Healthcare to conduct a pilot study to perform a detailed assessment of healthcare plastics and establish a recycling process for clinical settings. The full story can be found here: https://www.hprc.org/stanford-pilot-study.
- HPRC partnered with the PLASTICS Industry Association to facilitate a cooperative, first-of-its-kind regional recycling pilot study in the Chicago area. The recycling program focused on demonstrating a viable business model for the recycling of healthcare plastics on a regional basis. The full story can be found here: https://www.hprc.org/chicago-project.

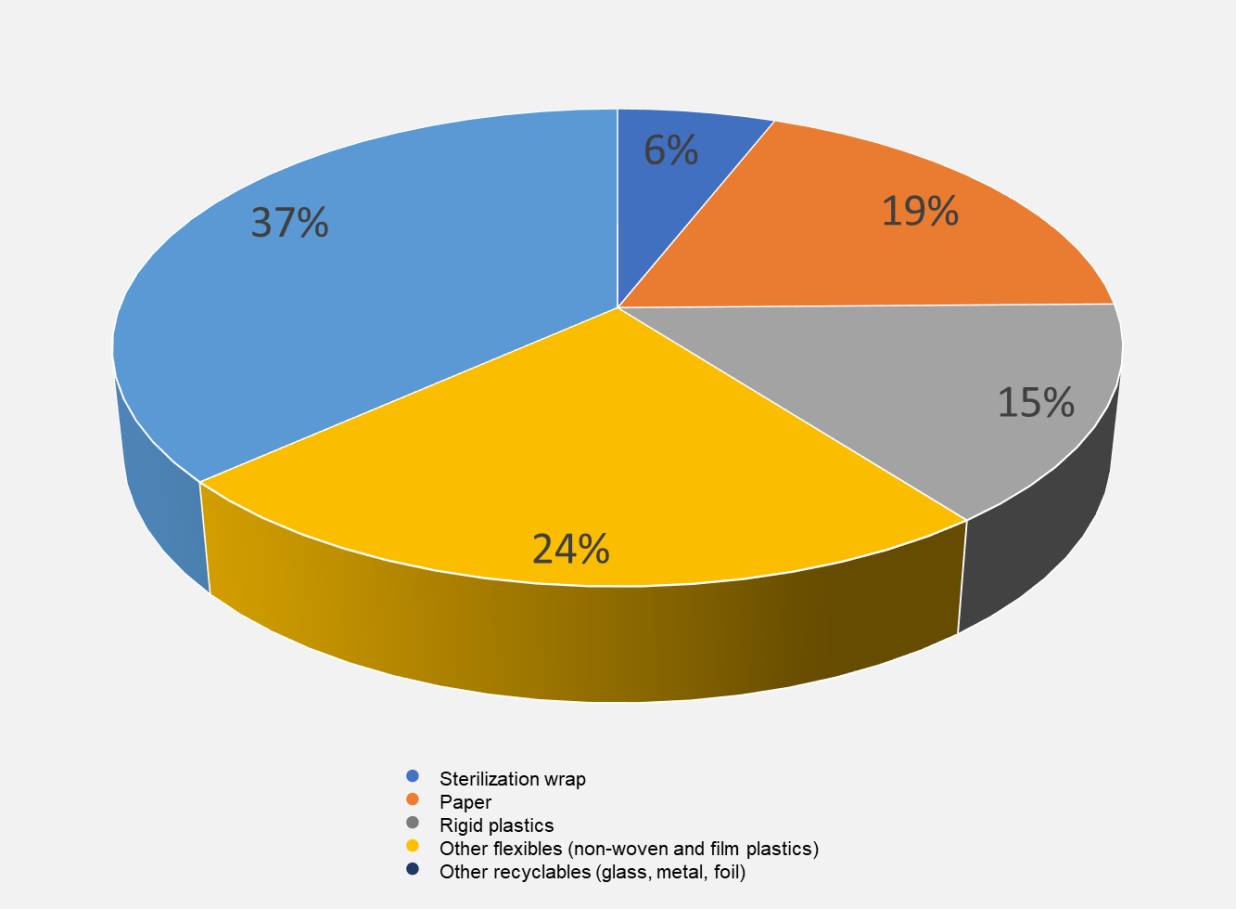
Trays

- Trays are commonly used to hold instruments for sterilization and distribution. Trays made from polyethylene terephthalate glycol (PETG) or high impact polystyrene (HIPS) are commonly sealed with Tyvek® Medical Packaging, to form a sterile barrier or placed in a flexible sterile barrier package.
- Extrusion grade HIPS is most commonly white in color with print, and once ground has a robust secondary market. Post-processing markets include horticultural trays, flower pots, points of purchase displays, and sheets.
- PETG is a highly engineered packaging material known for its chemical and heat resistance, impact strength, and clarity. In regrind form, PETG is used in fiber, non-FDA packaging, and chemical recovery of PTA (Purified Terephthalic Acid) and MEG (Mono Ethylene Glycol). See Appendix 1 for a typical medical-grade PETG technical specification.

Other Flexibles (Non-Woven and Film Plastics)

- Flexible packaging can be found in several areas in healthcare facilities. From supplies that are wrapped in linear low-density polyethylene (LLDPE) stretch film for shipment, to the secondary and tertiary packaging for healthcare products.
- At the primary packaging level, medical packaging films are sealed together or sealed to a breathable barrier material such as Tyvek® to make a flexible package. See Appendix 1 for Tyvek® technical specifications. Films can be a simple single-layer, low-density polyethylene (LDPE) or high-density polyethylene (HDPE), or multi-layered medical material (polyester, nylon, etc.) to achieve the desired properties.
- To process flexible plastics, densification and pelletization are required. When flexible plastics of different densities or materials are combined, compatibilizers may be used to improve product performance, which will increase utilization and value. Paper labels are frequently present.
- Predominantly natural or white in color, these materials can be used in lawn edging, pipe, roofing, and plastic lumber.

Figure 1: Relative Quantities of Healthcare Plastics Generated in Clinical Settings (by weight)



Partnering with Hospitals

Setting up partnerships with hospitals introduces some unique challenges compared with other recycling programs. This section provides some tips on how to partner with hospitals to create a successful healthcare plastics recycling program.

[Note: HPRC has created HospiCycle, a free toolkit for hospitals looking to start or expand their plastics recycling program, which might be useful in your discussions with hospital representatives.]

How do you get started?

Depending on the hospital, recycling programs run the gamut from comprehensive to virtually non-existent, so getting an understanding of the state of the hospital's program is the first step. Begin by requesting a meeting with a representative from the hospital. As hospitals become more focused on minimizing the environmental impacts of their operations and enhancing sustainability, many have established permanent positions for environmental, sustainability, or environment, health & safety managers (EHS).

If hospitals in your market have people working in these positions, this is a good indicator that their organizational objectives include waste minimization and working to improve recycling. By meeting with people in these roles, you will often find people eager to understand how you can support their recycling programs to achieve their waste diversion objectives.

For those facilities without programs in place for plastics waste segregation, recyclers should work with the facility to map out a streamlined collection process, including:

- What are you going to collect?
- When and where you are going to collect it?
- How you are going to collect, and who is going to do the collection?
- How will you move materials within the facility?
- How are you going to pick up the materials from the hospital and transport it to the recycling facility?
- Is it necessary to stockpile materials to meet certain quantities or increase the density, in order to improve the efficiency of transportation or meet recycling facility requirements?

Working with the hospital to ensure they have the right equipment to collect and transfer their recyclable healthcare plastics is important.

Equipment that should be considered includes a compacter, a baler, and additional dumpsters at the dock for dock-out processes. Carts, bins, and totes are also important for collecting materials within the hospital and transferring the materials from hospital functional areas to the dock.

As evidenced by the HPRC pilot program with Stanford Healthcare Pilot Study, and the case studies presented later in this guidance, hospitals can successfully implement targeted recycling programs to provide recyclers a stream of clean, high-volume, high-value items. Developing a dedicated process also minimizes the likelihood of contamination of the waste stream with unwanted materials.

Considering the healthcare plastics value chain diagram presented in the next section, it is important to understand the specific role you, or your company, plays in the overall system, or if your company fulfills multiple roles in the system.

As indicated in the diagram, there are potentially multiple types of service providers working directly with the hospitals to enable the recycling of healthcare plastics. These include waste haulers, third party collectors, and integrated service providers. In the following section, we define each of these roles in greater detail.

Finding synergies in waste pickup activities, i.e. using vehicles already making pickups at the hospitals, can streamline the transportation of recyclable materials from the hospitals and may help recyclers realize significant cost savings.

To that end, it is important to recognize that while hospital systems may want to improve their environmental footprint, they are facing unprecedented cost pressures and tightening margins. Recycling programs that increase hospital costs will have a harder time getting the necessary approvals from hospital leadership. To combat this, we suggest that recyclers spend time understanding the economics of the hospitals current waste removal programs and look to design programs that are both environmentally and economically beneficial.

Material Contamination

An obvious concern in working with materials sourced from clinical areas of a hospital is the potential for the materials to be infectious, contaminated with infectious materials, contaminated with hazardous materials (chemicals or medications), or contain sharps. Hospitals are very aware of these hazards and their responsibilities for ensuring proper management and disposal of these materials.

The largest source of healthcare plastics is operating rooms. Considering that the majority of healthcare plastics are generated while operating rooms are being set up for medical procedures, a common approach to minimizing the potential for contamination is to collect the materials 'pre-case,' meaning they are collected and removed from the procedure room before the patient is brought in.

It is important to work cooperatively with hospital representatives to set up appropriate processes to ensure hazardous materials are kept out of the recyclable material streams. First and foremost, there is a need for open dialogue to collectively agree on these practices and the steps that will be taken to prevent contamination and screen materials prior to shipment from the hospital.

It is also important for recyclers to work closely with hospitals to define non-conforming materials and what measures will be taken in the event materials are determined to be non-conforming when they are processed at a collection or recycling facility.

Commonly, hospitals will have environmental services staff (usually referred to as EVS) that handle the collection and disposal of waste from their facilities. Coordinating with these in-house or third-party administrators will also help facilitate the collection process.

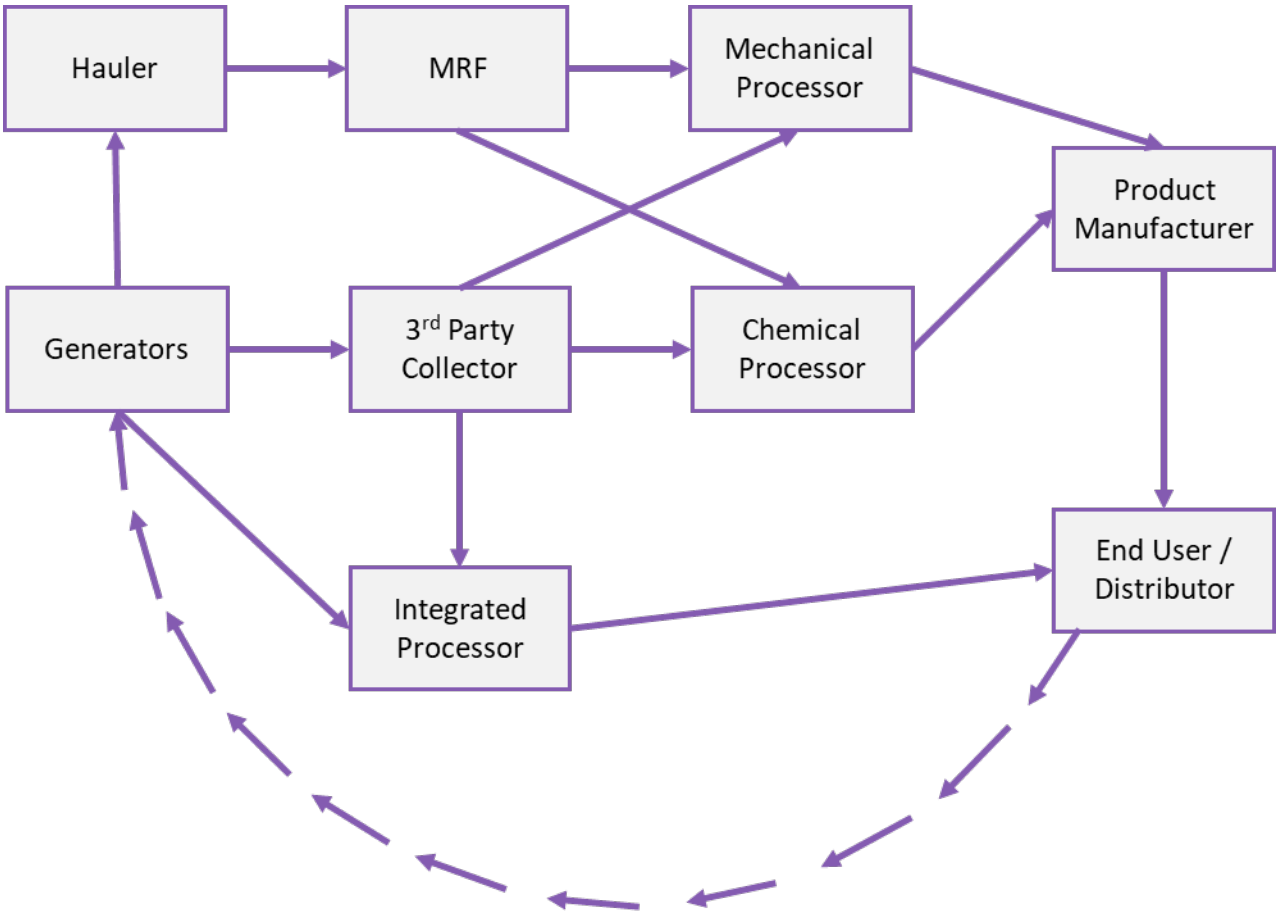
Assessing Hospital Recycling Readiness

HPRC has developed a series of questions that recyclers can use to establish an understanding of a hospitals recycling readiness, accessible at HPRC.org.

Healthcare Plastics Recycling Value Chain

HPRC understands that recyclers' capabilities vary significantly depending on the role they play in the plastics recycling value chain, and that priorities can change rapidly as they make changes in their operations to adapt to changing market conditions. HPRC has learned that the value chain for healthcare plastics recycling can be complicated (see Figure 2), and all stakeholders must understand the challenges, and associated costs, of collecting, sorting, and extracting value from healthcare plastics. Parties must work cooperatively to establish programs that will maximize benefits for all stakeholders. In the following sections, we provide descriptions of some of the different types of stakeholders that make up the healthcare plastics value chain.

Figure 2: Healthcare Plastics Recycling Value Chain Diagram



Mechanical Processors

Mechanical processors include service providers such as:

- Film Processors
- Compounders
- Plastics Recovery Facilities (PRF)
- Post-Industrial Recyclers

Currently, there are a number of companies recycling post-industrial medical supply scrap utilizing a range of separation technologies including optical, infrared, air, melt filtration, and density separation (float-sink), to produce marketable PP, PE, and HIPS repro resins. Additionally, there are other innovative companies founded on collecting nontraditional, but usable, scrap plastics (i.e. sterilization wrap) and making them into finished products.

Chemical Processors

Chemical processors recycle plastics utilizing chemical processes including:

- Solvent Extraction (PP & PE)
- Filtration (PP & PE)
- De-polymerization (PE, PET, and Nylon)
- Monomer Recovery (HIPS & PS)

We are beginning a new chapter in plastics recycling where we are able to produce virgin-like resins from recycled feed streams. Through depolymerization – breaking materials down to their monomer building blocks – there is the ability to truly close the loop. For the healthcare industry, this means providing recycled feedstock that can be used in products and packaging regulated by the FDA, whereas previously this market was restricted to virgin materials exclusively.

Companies developing these technologies need help sourcing adequate quantities of target materials containing the right types of resins in the right combinations, many of which can be found in healthcare settings.

Integrated Processors

Integrated processors can produce finished products from recycled materials such as:

- Plastic lumber
- Railroad ties
- Healthcare tubs and bins
- Drainage and pipes
- Packaging (non-FDA)

Integrated processors often take comingled olefin plastics (some of which contain non-plastic contamination) as feedstock to produce high-value products from materials which are typically challenging for recyclers. Comingled plastics are a hallmark of healthcare waste, so recyclers who can produce a useful product from these materials can find an ample supply of raw materials by teaming with healthcare partners.

Mechanically Processing Healthcare Plastics

Mechanical processing is a common option for recycling healthcare plastics. When considering mechanical processing, there are a number of steps depending on what materials are being processed, including:

- **Sorting & Grading** – Materials will generally arrive baled or loose in containers. An initial inspection and separation should be performed on a conveyor which incorporates magnets to remove unexpected metal. Materials can then be directed to the next designated process.
- **Size Reduction (Grinding, Shredding, and Pulverizing)** – Materials are reduced in size by a variety of methods to prepare the materials for either mechanical or chemical processing. Mechanical processes prefer 3/8" grinds, and chemical processes are optimized for smaller 1/4" grinds or powder. Always match your end-product to the process requirements.
- **Improved Processing (Densifying)** – Film and fiber must be densified for downstream processing. Combination technology is available to densify and pelletize film in one process. Balers can be used to consolidate film and provide more economical packaging for transportation to processors.
- **Contamination Removal (Wash Line & Float Sink)** – Contaminants are removed from the incoming waste stream by wash lines, and plastics, rubber, and metal are separated by float/sink lines. Melt filtration via screen packs or continuous filtration will also remove paper and other contaminants.
- **Product Value Improvement (Pelletizing)** – Plastics, once sized, can be reprocessed into uniform pellets. This will improve product value and quality, and provide options to add processing agents, colorant, and compatibilizers.
- **Product Value Improvement (Post Blending)** – In the final step before packaging, pellets can be blended to improve consistency in performance. Other pellets can be added to modify melt flow, color balance, and meet customer's specifications.
- **Packaging** – The processed plastics are typically packaged in gaylords, supersacks, or bags. It is also possible to use railcars for exceptionally high-volume material.

Case Studies

Healthcare plastics recycling is challenging but feasible, as demonstrated by the following case studies:

Providence (Portland, OR)

Like Mayo Clinic, the Providence network approaches recycling with an organizational commitment to healthcare and the planet, starting with do not harm and take responsibility for your environmental impacts. Read more here.

Goodwill and Kaiser Permanente

Learn about this unique arrangement which provides adults with disabilities the opportunity to gain valuable job training and work experience while enabling Kaiser Permanente to cost-effectively recycle non-infectious healthcare plastics. Read more here.

Mayo Clinic (Rochester, MN)

Mayo Clinic's Healthcare Plastics Recycling Program began in 2013. Glen Goodsell, Recycling Coordinator, had been getting requests from staff to recycle healthcare plastics and with the addition of a baler (originally purchased to recycle beverage bottles), a grinder, and a willing plastics buyer, all the pieces were in place to begin an expanded plastics recycling program.

From 2016-2017, the program saw a 78% increase in recycling in their #5, #6, and #7 plastics. There was also a 9% increase in #1 and #2 plastic recycling over that time frame. Even if your system differs from Mayo Clinic's, the expert advice their team has to offer may provide valuable support for your recycling efforts. Read more here.

Dartmouth Hitchcock

Read about a unique relationship between industrial, resource management, and healthcare stakeholders that enable each company to achieve their goals through a collaborative approach.

This case study will help show how to 'think outside the box' when visualizing potential arrangements with companies in your community. Read more here.

These impressive organizations commit their time and resources to actively seeking viable recycling alternatives for all of the waste they generate. This starts with dedicated people and facilities where all of the recyclable materials are sorted and packaged for shipment to recycling partners who offer the highest and best use for each commodity.

If your operations happen to be in the vicinity of a healthcare organization that takes recycling seriously as Mayo Clinic, Providence, Kaiser Permanente, or Dartmouth-Hitchcock, meet with them to find out how they can help you be successful in your recycling efforts.

Helpful Resources

Technical Assistance

- Economic Analysis for a Healthcare Recycling Program
- Building the Business Case for Hospital Recycling
- Plastics Mapping Tool for Hospital Recycling

Healthcare Plastics Terms

- **Sterilization Wrap** – "Blue wrap" sterile material that protects surgical instruments, commonly made from polypropylene.
- **Irrigation Bottles** – Used for irrigation in the OR, commonly made from polypropylene or high-density polyethylene.
- **Basins, Pitchers, and Trays** - plastic containers such as water pitchers and patient care basins and trays, commonly made from polypropylene.
- **Tyvek® Medical Packaging** – breathable sterile barrier material, made of high-density polyethylene, commonly utilized in sterile packaging.
- **Flexible Clear Packaging** - shrink wrap, stretch film, and plastic bags, commonly made from polyethylene.

References

- HospiCycle
- Stanford Pilot Study
- Chicago Pilot Study

Contacts & Links

- Practice Green Health
- PLASTICS
- Association of Postconsumer Plastics Recyclers
- Healthcare Plastics Recycling Council

Appendix 1:
Technical Specifications for Common Healthcare Plastics

Example specification for sterilization wrap polypropylene:

- 80% Homopolymer Polypropylene with a 20% Impact Modifier
- 40 melt
- 1.3 Izod
- 200,000 + flex
- 4800 + tensile
- Ash .08 or less

Example specification of irrigation bottle/cap, provided courtesy of Baxter:

- Resin type or number: Polypropylene Copolymer, FHR 23N10A
- Manufacturing (such as injection or extrusion grade): extrusion grade
- Melt rate: 9.5
- Density: 0.89 – 0.91 g/ml @ 77 °F (25 °C)
- Color: colorless
- If it's a homo or co-polymer: random co-polymer
- It has a white silicone (LSR) gasket and a paper label

Example specification of polyethylene terephthalate glycol (PETG), provided courtesy of Eastman, click here.

Example specification of Tyvek® Medical Packaging HDPE, provided courtesy of DuPont:

- Material Composition: over 99.8% High Density Polyethylene Homopolymer CAS# 9002-8-4
- Melt Index:
  - With 2.16 kg at 190C 0.6 to 0.82 g/10 min.
  - With 21.6 kg at 190C 24 to 37 g/10 min.
- Density: above 0.955 g/cc
- Ash: below 160 ppm