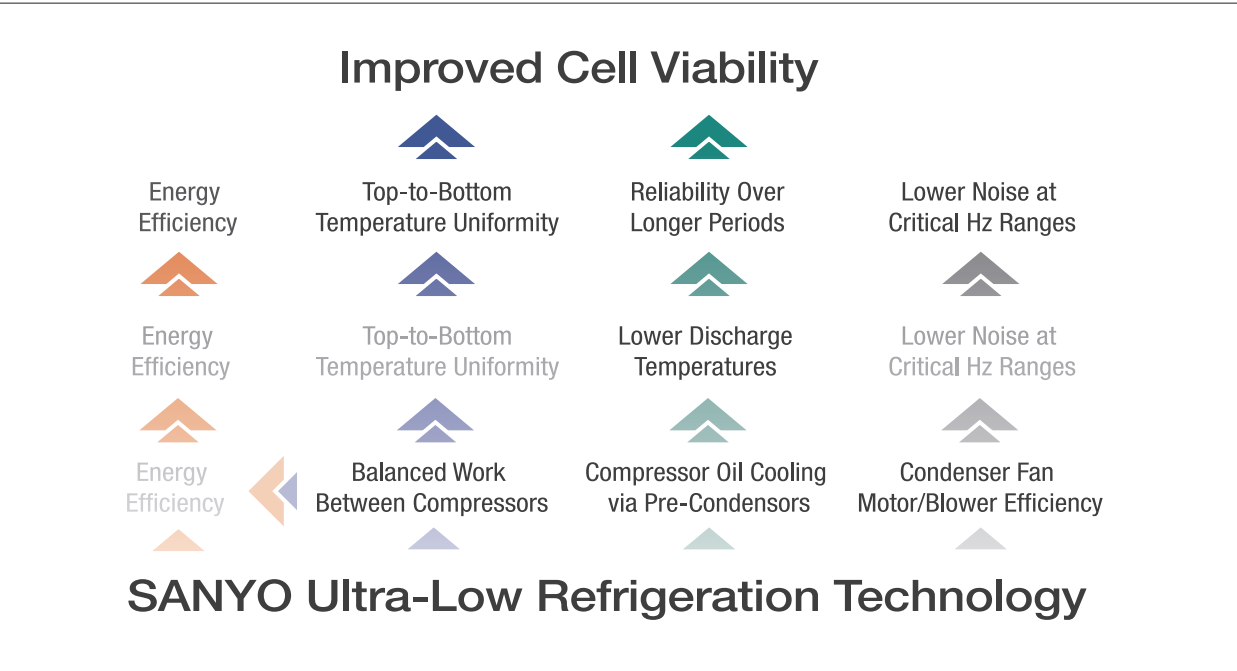


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The development of an application-specific refrigeration compressor for use in a mechanically refrigerated cascade system results in lower compressor discharge temperatures, more balanced workload between high and low stage compressor systems, and more efficient location of evaporator systems around the interior chamber in the -86°C ultra-low temperature freezer. As a result, the freezer delivers better chamber temperature uniformity necessary for stability of stored product. By apportioning the oil cooling function between specially designed SANYO compressors, and by cooling the compressor oil to minimize compressor operating temperatures, the SANYO ultra-low temperature freezer refrigeration system is balanced to decrease component stress, increase system longevity and reliability, and improve temperature uniformity necessary for better cell viability regardless of where the specimen is stored within the chamber.

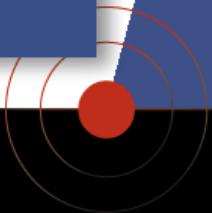
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SANYO ADVANTAGE SUMMARY	
<p><b>SANYO Advanced Ultra Low Refrigeration System</b></p>	<ul style="list-style-type: none"> <li>• Greater system longevity &amp; reliability</li> <li>• Minimizing compressor operating temperatures</li> <li>• Efficient location of evaporator systems around the interior chamber</li> <li>• Balanced refrigeration system</li> <li>• Better temperature uniformity, permitting the entire interior volume to be used for long-term storage.</li> <li>• Reduced noise at critical Hz ranges.</li> <li>• Enhanced viability of stored product.</li> </ul>
<p><b>SANYO Application Specific Compressor</b></p>	<ul style="list-style-type: none"> <li>• With lower compressor discharge temperatures and pressures, newer refrigerants can be more effective</li> <li>• Combined with SANYO's patented VIP® insulation, the migration of ambient heat from the laboratory to the interior is minimized</li> <li>• Refrigeration capacity is expanded and optimal application of evaporator coils around the interior chamber, a key to temperature uniformity and, ultimately, to cell viability</li> </ul>
<p><b>THINK Green, THINK GAIA</b></p>	<ul style="list-style-type: none"> <li>• SANYO is conscious of the need to protect our environment and conserve energy. As a corporate pioneer in life science and commercial equipment, and as a global source of solutions ranging from energy management to solar power and alternative energies, SANYO remains committed to providing the best possible laboratory equipment for research and clinical needs.</li> <li>• SANYO ULT GREEN Advantages: CFC Free Refrigerants; RoHS Compliance; Energy Efficiency Noise Reduction; Operating Costs; High Density Storage; Storage Volume Efficiency</li> </ul>

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PERFORMANCE	SANYO	Brand N	Brand R	Brand F
Temp Uniformity Range (setpoint @ -80°C)	4.2°C	9.0°C	12.5°C	7.7°C
Chamber Temp. Top (setpoint @ -86°C)	-86.0°C	-77.5°C	-81.4°C	-81.4°C
Max Warming Point, 10 sec. Opening (10 second door opening)	-75.0°C	-34.3°C	-57.7°C	-76.8°C
Noise Level (1 meter from unit)	43.8 dB(A)	51.7 dB(A)	52.0 dB(A)	72.0 dB(A)

No matter where you store your samples in a SANYO freezer, cell viability stay the same, top to bottom, front to back, side to side. The industry's best ultra-low temperature uniformity assures biological integrity. From short-term storage to long-term archiving as low as -86°C, SANYO ultra-low freezers maintain stable temperatures at all levels for post-thaw reproducibility. Our time-tested refrigeration technology, patented vacuum insulated panel insulation, microprocessor controls and inventory management systems adds up to proven performance.

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### SANYO ULTRA-LOW TEMPERATURE FREEZER TESTING PROTOCOL

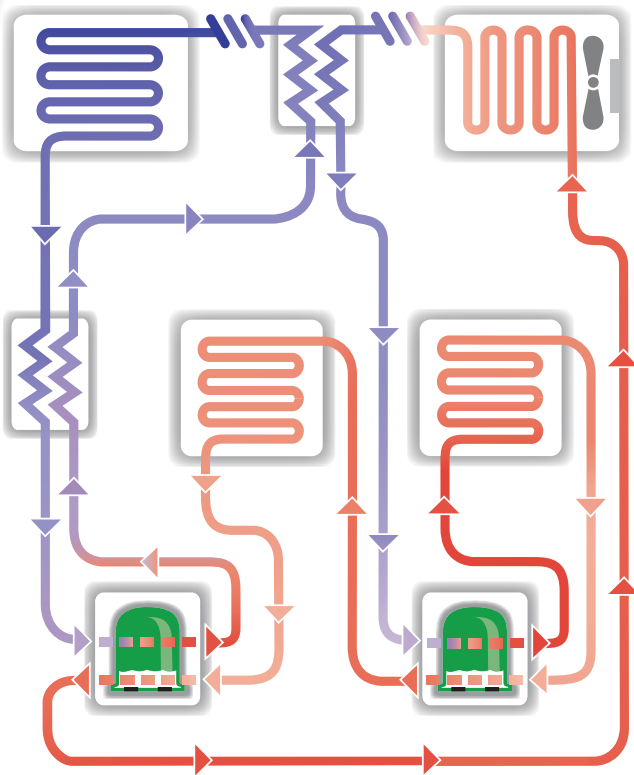
<b>Ambient Temperature</b> During Test	+35°C. Important: Performance testing and published data on SANYO ultra-low temperature freezers is based on extensive testing in a +35°C ambient to simulate worst-case conditions. When comparing performance of competitive ultra-low freezers it is important to establish and verify conditions under which tests are performed. Tests performed at temperatures below +35°C may exhibit lower compressor discharge temperatures; these discharge temperatures are not typical of real-world conditions, however, and should be used with caution when evaluating new or replacement freezer selection. For summary information on SANYO test conditions contact SANYO.
<b>Voltage Range</b> During Test	Variable. For 220V, AC, 60Hz models testing is conducted over voltages ranges starting as low as 202V to simulate brown-out conditions typical of real-world installations.
<b>Freezer Load</b> During Test	Variable. Thermal mass of a fully loaded freezer at equilibrium under normal ultra-low temperatures yields the best performance data. SANYO freezers are tested under empty, half-load and full-load conditions.

Testing and Evaluation: Consumer Advisory Performance testing and published data on SANYO ultra-low temperature freezers is based on extensive testing in a +35°C ambient to simulate worst-case conditions. When comparing performance of competitive ultra-low freezers it is important to establish and verify conditions under which tests are performed. Tests performed at temperatures below +35°C may exhibit lower compressor discharge temperatures; these discharge temperatures are not typical of real-world conditions, however, and should be used with caution when evaluating new or replacement freezer selection.

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**Figure 1, SANYO Cascade Refrigeration System:**  
The SANYO cascade refrigeration system employs two independent refrigeration circuits indirectly connected by an interstage heat exchanger. SANYO's proprietary integrated lubricating oil cooling system<sup>®</sup> automatically apportions the workload between compressors and permits both compressors to operate well within the expanded performance envelope.

SANYO's new ultra low temperature compressor employs a unique orientation of conventional components to reduce discharge temperatures and compressor heat while using commercially available refrigerants and lubricants. Heat reduction results range from as low as 25°C below previous SANYO compressors and more than 40°C below leading brand compressors used by numerous competitors. At the heart of the SANYO solution is a compressor oil cooling loop that reapportions the working heat byproduct between the low stage compressor and the high stage compressor. Due to low molecular weights in low stage refrigerant formulations, low stage compressors must work harder to achieve cooling targets.

The SANYO technique uses existing lubricating oil to cool the low stage compressor, passing the resulting heat load to the high stage compressor which, by design, is already doing less work. By shifting a portion of the burden from the low stage to the high stage, SANYO balances the load on both compressors while reducing operating pressures and keeping heat loads and discharge temperatures well within tolerances required to prevent chemical breakdown of oils and refrigerants.

As a result, refrigeration capacity is expanded and structural engineers have more latitude in strategic application of evaporator coils around the interior chamber, a key to temperature uniformity and, ultimately, to cell viability.

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**Low Stage Capillary Tube.**

Liquid refrigerant under pressure is passed through the capillary tube where it flash evaporates in the low stage evaporator to absorb energy (heat) from the product stored in the freezer.

**Freezer Cabinet with Evaporator.**

The evaporator coil is strategically wrapped around the interior chamber and concealed within the composite wall of vacuum insulation panels and conventional foamed-in-place urethane insulation.

**Low Stage Refrigerant.**

Commonly available worldwide, R508.

**Low Stage Heat Exchanger.**

Energy is absorbed by the refrigerant gas and transferred to the low-stage heat exchanger to cool discharge gas.

**Low Stage Compressor.**

The compressor pumps refrigerant through the low stage circuit.

**Low Stage Oil Reservoir.**

High stage refrigerant passes through the low-stage oil sump to cool lubricating oil resulting in high-stage compressor energy being to minimize the workload on the low stage compressor.

**Air Cooled Pre-Condenser.**

Removes energy (heat) from the high stage refrigerant enroute to the low stage compressor.

**Interstage Heat Exchanger.**

Energy is transferred to the high stage circuit.

**High Stage Capillary Tube.**

Liquid refrigerant under pressure is passed through the capillary tube where it flash evaporates in the interstage heat exchanger to absorb energy (heat) from the low stage refrigerant circuit.

**Main Condenser and Motor/Fan Assembly.**

The motor/fan assembly blows ambient air across condenser coils to move energy (heat) from the high stage refrigerant to the ambient environment.

**High Stage Refrigerant.**

Commonly available worldwide. A combination of R134a and R410a (Puron®) selected for optimum cooling performance in compliance with international environmental protection laws.

**Air Cooled Pre-Condenser.**

Removes energy (heat) from the high stage refrigerant enroute to the high stage oil reservoir.

**High State Compressor.**

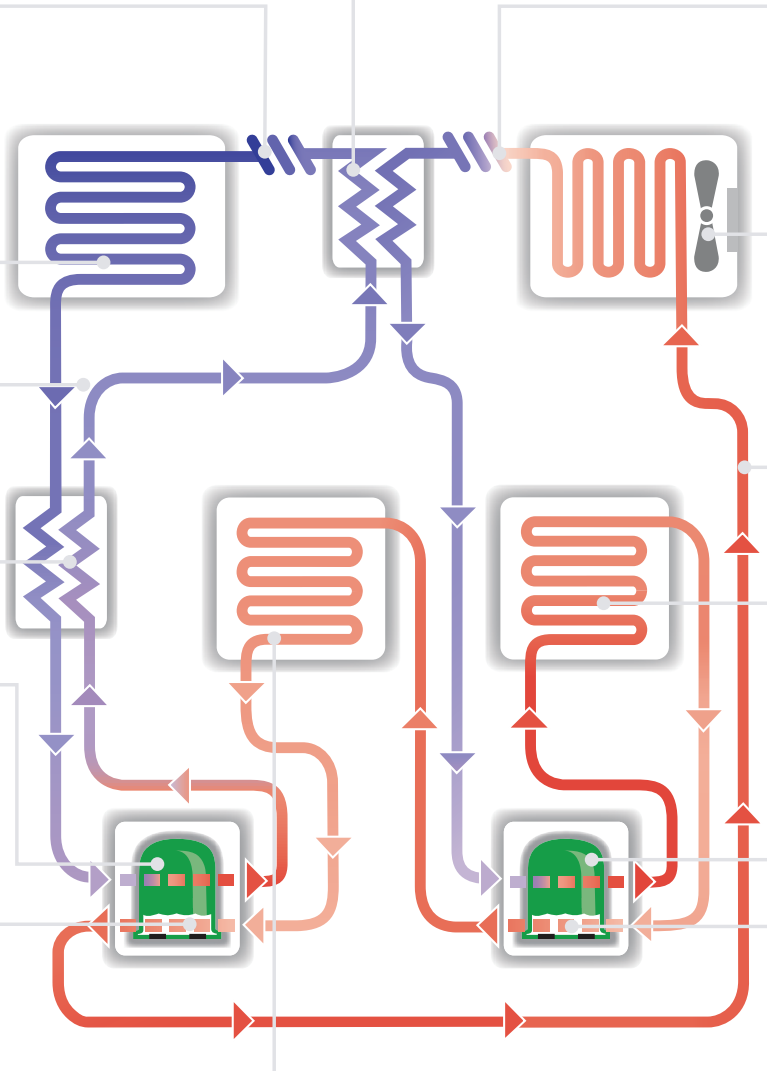
The compressor pumps refrigerant through the high stage circuit.

**High Stage Oil Reservoir.**

High stage refrigerant passes through the high stage sump to cool lubricating oil en route to the low stage compressor through the air-cooled pre-condenser.

**Instrumentation (Not Shown).**

Temperature and pressure sensors throughout the high and low stage circuits transmit information to the SANYO Status 3 central controller for operation, monitoring and interpretation.



**Figure 1, SANYO Cascade Refrigeration System:**  
The SANYO cascade refrigeration system employs two independent refrigeration circuits indirectly connected by an interstage heat exchanger. SANYO's proprietary integrated lubricating oil cooling system<sup>6</sup> automatically apportions the workload between compressors and permits both compressors to operate well within the expanded performance envelope.

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