

1.0 General Information

Device Generic Name	Electrophysiology Ablation Catheter Cardiac Ablation Generator (RF)
Device Trade Name	IBI Therapy™ Dual 8™ Ablation Catheter IBI-1500T6 (USA) Cardiac Ablation Generator
Applicant's Name and Address	Irvine Biomedical, Inc. ("IBI") 2375 Morse Ave. Irvine, CA 92614
Date of Panel Recommendation	None
Premarket Approval Application (PMA) #	P040042
Date Notice of Approval of Application	November 18, 2005

2.0 Indication for Use

The IBI Therapy™ Dual 8™ Ablation Catheter is intended for use with the IBI-1500T6 (USA) 100 watt generator at a maximum of 100 watts. The catheter is intended for creating long, linear endocardial lesions during cardiac ablation procedures (mapping, stimulation and ablation) for the treatment of typical atrial flutter.

The IBI-1500T6 (USA) Generator is intended for use with temperature controlled compatible ablation catheters for creating endocardial lesions. The generator may be used with the IBI Therapy™ Dual-8™, the IBI Therapy™ Catheter. The generator is internally limited to 50 watts when used with the IBI Therapy™ catheters.

3.0 Contraindications

Do not use the IBI Therapy™ Dual 8™ Ablation Catheter:

- In patients with active systemic infection; and
- If the patient has intracardiac mural thrombus or has had a ventriculotomy or atriotomy within the preceding four weeks.

4.0 Warning and Precautions

The warnings and precautions can be found in the IBI Therapy™ Dual 8™ Ablation Catheter and the IBI-1500T6 (USA) Cardiac Ablation Generator labeling.

5.0 Device Description

The IBI Therapy™ Dual 8™ Ablation Catheter is a sterile, single use catheter with one 8mm ablation electrode at the tip and three diagnostic electrodes. The catheter includes temperature sensors at the tip electrode for temperature monitoring and the handle is equipped with a push-pull type thumb control for steering to deflect the distal tip of the catheter. The Therapy™ Dual 8™ Ablation Catheter is offered in six curve variations.

Therapy™ Dual 8™ Ablation Catheter Specifications

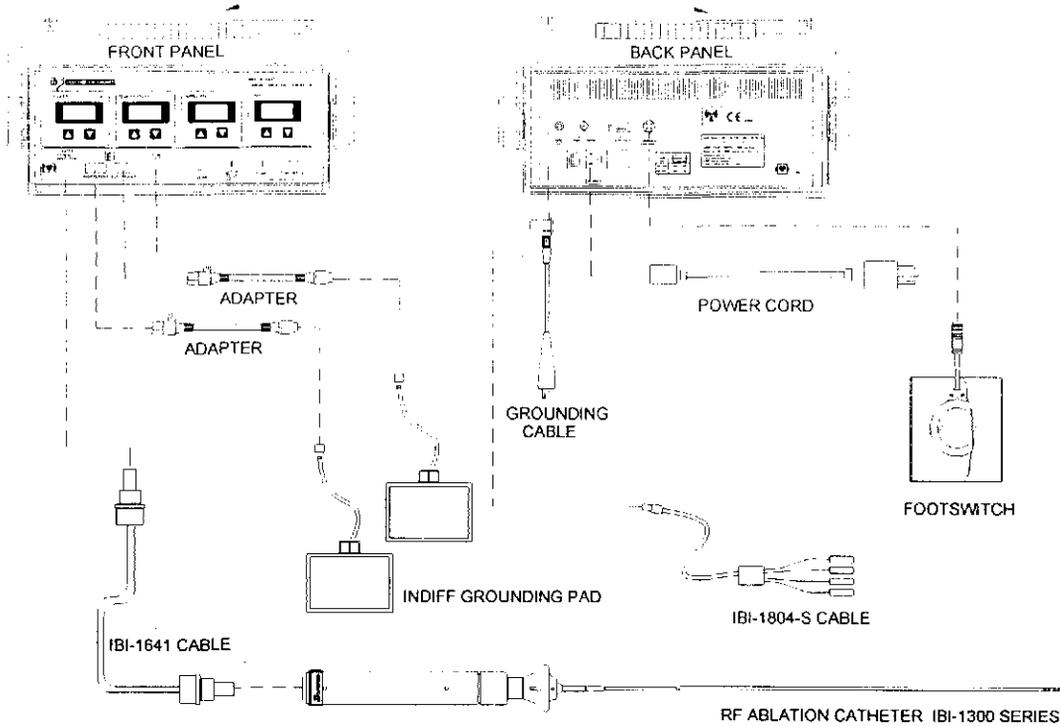
Feature	Specification	
Catheter Diameter	7 French	
Catheter Usable Length	110 cm (approximate)	
Number of Electrodes	Four (1 Ablation and 3 Diagnostic)	
Tip Electrode	8 mm	
Band Electrodes	Three, 2 mm width	
Interelectrode Spacing	2mm-5mm-2mm	
Temperature Sensor	Thermocouple, Type T	
Curve Type	Steerable, Uni-directional	
Curve Configurations	1304-7-25-S-TE8TC2	0.66" (1.7cm) Curve Diameter
	1304-7-25-M-TE8TC2	0.875" (2.2 cm) Curve Diameter
	1304-7-25-L-TE8TC2	1.125" (2.85 cm) Curve Diameter
	1304-7-25-XL-TE8TC2	1.375" (3.5 cm) Curve Diameter
	1304-7-25-E-TE8TC2	1.5" (4.0 cm) Curve Diameter
	1304-7-25-F-TE8TC2	1.5" (4.0 cm) Curve Diameter
Connector Configuration	Redel type	

The IBI 1500T6 (USA) Cardiac Ablation Generator is a 100 Watt Radio Frequency generator with accessories. The generator produces a continuous unmodulated radiofrequency (RF) output near 485 kHz and a maximum power output of 100 Watts. RF power from the generator is delivered in a monopolar mode between the distal electrode of the Therapy™ Dual 8™ Ablation Catheter and the commercially available dispersive pads.

The generator is temperature controlled, where temperature measured by the temperature sensor in the Therapy™ Dual 8™ Ablation Catheter is monitored and the power delivered by the generator is adjusted within the user selected limit until the desired temperature is achieved. The generator provides safety power shutoffs based on pre-determined time, temperature, power and impedance settings. The generator includes a front panel for display and user interface. The physician may establish settings for the following parameters: temperature, impedance, power and time.

Setup Diagram for Catheter and Generator

IBI-1500T6 USA GENERATOR



6.0 Alternate Practices and Procedures

Therapeutic alternatives for patients with Type I atrial flutter includes direct surgical ablation, RF catheter ablation with other approved diagnostic/ablation catheters, use of drugs for arrhythmia control, and antiarrhythmia pacing.

7.0 Marketing History

Neither the catheter nor the generator have been previously marketed in the United States. Therapy™ Dual 8™ catheters and the IBI 1500T series generators have been marketed internationally including Europe, Asia, and Australia. Neither the catheter nor the generators have been withdrawn from market in any country for any reason related to safety and effectiveness.

8.0 Potential Adverse Effects of Device on Health

Potential Adverse Events

Potential adverse events associated with catheterization and/or cardiac ablation include the following:

- Adult Respiratory Distress Syndrome (ARDS)
- Air embolism
- Anemia
- Anesthesia reaction
- Arrhythmias
- AV fistula
- Cardiac perforation/tamponade
- Cardiac thromboembolism
- Cerebrovascular accident (CVA)
- Chest pain/discomfort
- Complete heart block
- Component damage to ICD or implantable pacemaker
- Congestive heart failure
- Coronary artery spasm
- Death
- Dislodgement of implantable cardioverter defibrillator or permanent pacing leads
- Endocarditis
- Exacerbation of pre-existing atrial fibrillation
- Expressive aphasia
- Heart Failure
- Hemothorax
- Increased phosphokinase level
- Infections
- Laceration
- Leakage of air or blood into the lungs or other organs due to perforation
- Local hematomas/ecchymosis
- Myocardial infarction
- Obstruction or perforation or damage to the vascular system
- Pericardial effusion
- Pericarditis
- Phrenic nerve damage
- Pleural effusion
- Pneumonia
- Pneumothorax
- Pseudoaneurysm
- Pulmonary edema
- Pulmonary embolism
- Radiation injury
- Respiratory Depression
- Seizure
- Skin burns
- Temporary complete heart block
- Thrombi
- Thromboembolism
- Transient ischemic attack (TIA)
- Unintended (in)complete AV, sinus node or other heart block or damage
- Valvular damage/insufficiency
- Vascular bleeding
- Vasovagal reactions
- Ventricular tachycardia
- Worsening chronic obstructive pulmonary disease

9.0 Summary of Nonclinical Laboratory Studies

In vitro testing

A series of *in vitro* bench tests were conducted based upon the FDA guidance document, "Cardiac Ablation Preliminary Guidance", March 1995 to verify device conformance to the functional requirements defined in the product specifications. The integrity of assembled components and the proper function of the ablation catheter for its intended use were confirmed through specific tests designed to test physical and performance characteristics of the device. A summary of the tests performed on the ablation catheter is presented in the table that follows.

	Test	Requirement	Result
R e l i a b i l i t y T e s t s	Performance Reliability	Electrical continuity on 10 catheters after 10 cycles of simulated RF ablation	Pass
	Torsional Testing (joint integrity)	No tip and tube joint failure on 30 subassemblies and 6 catheters after 1-2 shaft rotations with tip fixed	Pass
	Catheter Tensile Testing (Bond Strength / Joint Seal)	Tensile strength of tip-tubing bond and tubing fused joint ≥ 3.37 lbs on 10 catheters. Measure tensile strength after deflection/flexion on 10 catheters	Pass
	Handle/Shaft Tensile Strength	Tensile strength of catheter shaft to handle joint ≥ 3.37 lbs on 10 catheters	Pass
	Deflection Fatigue and Flexion Fatigue (Catheter Integrity after repetitive Deflection and Flexion cycles)	Electrical continuity with resistance ≤ 7.0 ohms and tensile strength ≥ 3.37 lbs after 60 repetitive deflection and 60 flexion cycles on 10 catheters	Pass
	Dielectric Strength	No breakdown after 500 VAC for 60 sec. between conductors on 10 catheters	Pass
	Catheter Detection and Power Limitation	Verify repeatable, accurate detection of Therapy™ and Therapy™ Dual 8™ catheters with corresponding power limitation of 50W and 100W, respectively, using three generators and four types of catheters	Pass
	Performance Reliability	No mechanical breakdown after multiple applications of RF energy on 10 catheters	Pass

	Test	Requirement	Result
M e c h a n i c a l T e s t s	Steering (Simulated pull - straight and curved) post 8 hour soak	Measure catheter pull force through simulated arch straight and deflected on 10 catheters	Pass
	Bending	Measure shaft deflection with force applied at midpoint on 10 catheters	Pass
	Buckling Load (Buckling Force)	Buckling load \leq 200 grams under simulated use conditions on 10 catheters	Pass
	Radiopacity	Fluoroscopic visualization of catheters under simulated clinical conditions on 10 catheters	Pass
	Torque/Twist Angle	No electrical and mechanical failure at 180°-720° twist angle on 10 catheters	Pass
	Leak Pressure Test	No leaks or tubing bond failure at 10 psi on 15 subassemblies	Pass
E l e c t r i c a l T e s t s	RF Impedance	\leq 300 ohms impedance at operating frequency on 10 catheters	Pass
	Noise	Clear EKG signal during simulated use on 10 catheters	Pass
	Stimulation (Pacing)	Using PSA and EKG monitor, stimulate the heart and measure output levels at 120 bpm on 10 catheters	Pass
	Mapping	Clearly visible and identifiable EKG signals under simulated use on 10 catheters	Pass
	Electrical Resistance	DC resistance \leq 7 ohms of conductor circuit on 10 catheters	Pass
	Leakage Current post 8 hour soak	Electrical leakage \leq 10 μ A at 400VDC on 10 catheters	Pass
	AC Impedance	Measure AC impedance at 5 kHz and verify \leq 1.0% signal loss on 10 catheters.	Pass
	High Frequency Leakage Current	\leq 4.02 mA/cm leakage at 400 Volts at 485 KHz in saline bath on 10 catheters	Pass
	Thermal Response and Accuracy	\pm 3° C accuracy of temperature sensor and measure sensor response time on 10 catheters	Pass
C a b l e	Connector Engagement and Separation Force Report	Tensile force to engage and disengage the connector is 3.0 lbs or less on 15 samples	Pass
	Accessory Cable Flex Fatigue Report	Maintain electrical continuity (resistance measurement) after 50 flexion cycles on 15 samples	Pass
	Dielectric Strength Breakdown Report	< 5% with no dielectric breakdown at 500VAC on 10 samples	Pass
	Cable Tensile Pull Test Report	No breaks under 10.0 lbs on 15 samples	Pass

In summary, all tested catheters met the established acceptance criteria for all tests.

Biocompatibility testing

The patient contacting materials of the IBI Therapy™ Dual 8™ Ablation Catheter were tested using a representative catheter in accordance with ISO 10993 for external communicating devices in contact with circulating blood for limited/transient duration. Biocompatibility testing was performed to GLP standards and in accordance with applicable parts of ISO 10993 and establishes biocompatibility and material safety as used in the device.

Comparison of Test Article to Therapy™ Dual 8™ Catheter (Patient Contact Materials)

Component	Ultrasound Material (Test Article)	Luma-Cath Material (Test Article)	Therapy™ Dual 8™ Material	Patient Contact
Extruded Shaft	Pebax™ polyether block amide thermoplastic	Pebax™ polyether block amide thermoplastic	Same (Pebax™)	Direct Tissue and Blood
	Urethane			
Tip	Platinum/Iridium (90/10%)	Platinum/Iridium (90/10%)	Same	Direct Tissue and Blood
Band Electrodes	Platinum/Iridium (90/10%)	Platinum/Iridium (90/10%)	Same	Direct Tissue and Blood
Adhesives	Urethane Adhesive	Urethane Adhesive	Same	Indirect
	Cyanoacrylate	Cyanoacrylate	Same	Indirect
Handle	Acetal	Acetal	Same	Indirect

Biocompatibility Testing Performed

Biological Effect	Test	Method	Result
Cytotoxicity	Cytotoxicity	ISO 10993-5, 1X MEM Extract	Pass
Sensitization	Sensitization	ISO 10993-10, maximization in guinea pigs	Pass
Irritation or Intracutaneous Reactivity	Intracutaneous Reactivity	ISO 10993-10	Pass
Systemic Toxicity	Systemic Toxicity	ISO 10993-11, intravenous and intraperitoneal routes in mice	Pass
Hemocompatibility	Hemolysis	ISO 10993 – <i>In Vitro</i> Procedure (Extraction Method)	Pass
	In-Vivo Thromboresistance	ISO 10993 (In Dog, Venous Implant)	Pass
	Plasma Recalcification	International Organization for Standardization	Pass
Pyrogenicity	Rabbit Pyrogen Test	ISO 10993-11, Material-Mediated Rabbit Pyrogen	Pass

Packaging/shelf life/sterilization testing

Package sealing was validated and packaging integrity was performed after subjecting the packages to shipping and distribution stresses according to International Safe Transit Association procedure ISTA 2A Transportation Protocol. Real-time and accelerated aging were performed to support the shelf-life of three years for the catheter.

The catheter is sterilized with ethylene oxide (EtO) gas. The sterilization process was validated based on the recognized standard ISO 11135: 1994, Medical devices -- Validation and routine control of ethylene oxide sterilization. The process validation demonstrated that the sterilization process renders products sterile to a sterility assurance level (SAL) of 10^{-6} . Residual levels for EtO and ECH met the requirements for limited exposure devices in accordance with recognized standard ISO 10993-7 Biological evaluation of medical devices -- Part 7: Ethylene oxide sterilization residuals.

In vivo animal studies

The safety and effectiveness of the IBI Therapy™ Dual 8™ Ablation Catheter with the 100 watt RF ablation generator was demonstrated in a canine model. Five (5) dogs were used in the acute portion of the study, and five more were used for the chronic study. The catheter handled adequately, was able to acquire intracardiac electrograms and produce area specific lesions as expected.

Electrical Safety and EMC Testing

Electrical Safety testing was performed on the RF ablation generator in accordance with the requirements of ISO 60601-1 and Electromagnetic compatibility (EMC) testing was performed in accordance with the requirements of ISO 60601-1-2. The device passed all tests. The device utilizes non-volatile, preprogrammed firmware. During development, the firmware was tested independently and then integrated into the hardware and tested at a system level.

10.0 Summary of Clinical Studies

10.1 Objectives

A prospective, multicenter study of RF ablation was conducted to demonstrate the Safety and Effectiveness of the IBI Therapy™ Dual 8™ Ablation Catheter used in conjunction with the IBI Cardiac Ablation Generator.

10.2 Study Design

The Device was evaluated in a prospective, non-randomized, multi-center clinical study for the treatment of isthmus dependent atrial flutter (typical AFL).

The objective of the clinical study was to demonstrate the safety and effectiveness of the Device for the treatment of AFL. Interpretation of the results was based primarily on objective performance criteria (OPC) regarding acute procedural success and rate of Major Complications. The OPC are defined below:

- **Safety:** major adverse events within 7 days of the procedure occur at a rate of **2.7%** or less with a **7%** one-sided 95% confidence bound;
- **Acute success:** **88%** with an **80%** one-sided 95% confidence bound.

Effectiveness

“Acute success” was defined as the creation of bi-directional conduction block across the IVC/TA isthmus (confirmed 45 to 60 minutes after the last ablation treatment) and non-inducibility of atrial flutter using only the study catheter. Due to the strong correlation of acute bi-directional conduction block with chronic success, and in consideration of FDA's current practices, the acute endpoint of bi-directional conduction block also serves as a surrogate measure of chronic success.

“Chronic success”, a secondary endpoint, was defined as the absence of recurrence of the target arrhythmia over a 3-month period following an acute success. “Conditional chronic success” was defined as freedom from recurrence among acute procedural successes. “Conditional chronic success free of antiarrhythmic drug changes” refers to any Class Ia, Ic, or III antiarrhythmic that is newly introduced following the index procedure or whose dosage is increased compared to the pre-ablation dosage.

Safety

“Major Complication” was defined as any occurrence of death, cardiac tamponade, myocardial infarction, stroke, perforation, valvular damage (new mitral or tricuspid damage), inadvertent AV block, coronary artery injury, arterial thrombosis, pulmonary embolism, thromboembolic event (stroke or TIA), peripheral venous thrombosis, endocarditis, hemothorax, pneumothorax, sepsis, catheter insertion site hematoma or AV fistula requiring a blood transfusion and/or surgical repair or any other “serious” cardiovascular adverse event within one week of the study ablation.

“Serious” was defined as any event that was:

- Life threatening; or
- Resulted in permanent impairment of a body function or permanent damage to a body structure; or
- Necessitated significant intervention, such a major surgery, to prevent permanent impairment of a body function or permanent damage to a body structure; or
- Required hospitalization or an extended hospital stay; or
- Resulted in moderate transient damage to a body structure; or
- Required intervention to prevent permanent impairment of a body function or damage to a body structure.

“Minor Complication” was defined as any non-serious cardiovascular adverse event within one week of the study ablation. A non-serious event was any reported sign, symptom or diagnosis that did not satisfy any of the criteria for “serious” described above.

Data collection included basic demographics, presenting signs and symptoms, characteristics of the index arrhythmia, procedural parameters (ablation duration, impedance, power and temperature), cardiac medications, treatment outcome, adverse events and assessments for recurrence of the treated arrhythmia. Patients were evaluated one and three months after the initial ablation procedure.

10.3 Subjects Studied

Status	Number of Patients
Screened	168
Discontinued	18
Non-protocol arrhythmia (2 mapped with IBI catheter)	9
Other Screen Failure	5
Withdrew Consent	2
MD Consent	1
Equipment Not Available	1
Treated	150

10.4 Demographics

Of the 150 patients undergoing RF ablation, 27 (18.0%) were female and 123 (82.0%) were male. The average age (\pm SD) of all treated patients was 65.6 (\pm 10.2) (range 33-88). All of the patients had arrhythmia symptomatic at the time of ablation. The most commonly reported symptoms were dyspnea (55.3%), fatigue (53.3%) and palpitations (52%).

Overall, 42.0% of patients were receiving anti-arrhythmic medications.

The enrolled patients had an average of four co-morbid conditions each and only 2.7% (4/150) were free of baseline co-morbidities.

10.5 Procedural Data

Energy was applied a total of 1,818 times with an average of 12.4 (± 11.5) applications per patient (range 1-60). The mean duration of energy delivery per application was 93.0 (± 58.4) seconds (range 1-200) at an average temperature of 51.4 (± 6.8) degrees (range 20-85). The vast majority of applications were directed to the region between the tricuspid annulus and the inferior vena cava.

Mean fluoroscopy time was 24.0 (± 18.4) minutes (range 0.9-106) and mean procedure time (treatment phase with the study catheter) was 59.3 (± 36.2) minutes (range 7-191). Procedure time was defined as the number of minutes from the first ablation attempt until the last ablation attempt with the Device. Average study time (procedure time plus waiting time) was 106.6 (± 39.9) minutes (range 20-255).

Two patients received ablation therapy during the index ablation procedure for concomitant arrhythmias.

Parameter	n	mean \pm SD	Range
# RF applications per procedure	147	12.4 \pm 11.5	1-60
RF time (min) per procedure	147	19.2 \pm 16.7	0.12-108.3
Fluoroscopy time (min) per procedure	145	24.0 \pm 18.4	0.9-106
RF usage time [*] (min)	147	38.3 \pm 37.6	0-197
Procedure time [*] (min) per patient	122	59.3 \pm 36.2 ^x	7-191
Study time ^b	123	106.6 \pm 39.9 ^x	20-255
RF time (sec) per application		93.0 \pm 58.4	1-200
Temperature ($^{\circ}$ C) per application		51.4 \pm 6.8	20 ^{&} -85
Power (Watts) per application		47.7 \pm 19.0	1 ^{&} -100
Impedance (Ohms) per application		82.6 \pm 13.1	39 ^{&} -150

^{*}procedure time is defined as the time mapping started until the time of last ablation

^x does not include 25 cases because the mapping time was not recorded

^{*}RF usage time is defined as the time from the first ablation to the last ablation

^b is the time mapping starts until the time of last catheter withdrawal

[&] Reported values are lower than actual expected minimum values but reflect documented parameters.

10.6 Results

Effectiveness:

ENDPOINT	N	Successes	PERCENT	95% CL
ACUTE PROCEDURAL SUCCESS	150	140	93.3%	89.3%
CONDITIONAL CHRONIC SUCCESS	140	137	97.8	94.9%
CONDITIONAL CHRONIC SUCCESS FREE OF ANTIARRHYTHMIC DRUG CHANGES	140	118	84.3	78.4%
OBJECTIVE PERFORMANCE CRITERIA (OPC)	--	--	88.0	80.0

Safety:

EVENT DESCRIPTION	N	Patients With Event(s)	PERCENT	95% CL
ALL MAJOR COMPLICATIONS	152*	17	11.2	16.0
OBJECTIVE PERFORMANCE CRITERIA (OPC)	--	--	2.7	7.0

* 2 patients had the IBI device inserted into the vasculature, but were not ablated

Observed Adverse Events:

Among the 150 study subjects who underwent RF ablation, 18 major complications in 17 subjects were observed within 7 days of the procedure. See table below. There were no unanticipated, serious device-related adverse events.

Type of adverse event within 7 days	Number of patients
Acute myocardial infarction	1
Atrial fibrillation episode post ablation	2
Ectopic atrial tachycardia post ablation	1
Pulmonary emboli	1
Abnormal echocardiogram post ablation (wall motion abnormalities and decreased EF)	1
Skin burn	2
Hematoma	1
Sedation related	3
UTI	1
Treatment of pre-existing condition	3
Diagnostic hospitalization	1

There was one death during the clinical study. The patient was a 42 year old woman with a history of asthma, mild CHF and atrial flutter. Her ablation procedure was described as uneventful and acutely successful. She had recurrence of her atrial flutter 6 weeks post ablation and developed a cerebral embolus after cardioversion. She died of respiratory complications during the resulting hospitalization.

Comparison of OPC and results from clinical study of Therapy™ Dual 8™ show that the OPC for effectiveness was met but the safety OPC was not. An overall risk benefit evaluation of these adverse events was performed and a detailed review of each adverse event was completed. The adverse event rate described above was assessed to be specifically correlated to the increased number of co-morbid conditions present in the subject population enrolled relative to patient population from which the OPC's were derived.

11.0 Conclusions Drawn From Studies

Preclinical testing demonstrates that the Therapy™ Dual 8™ Cardiac Ablation Catheter should maintain mechanical and electrical integrity, and materials which contact patients are biocompatible under the proposed conditions for use. Bench testing has established an acceptable degree of energy delivery, accuracy and control.

Clinical data submitted under PMA P040042 provide reasonable assurance that the Therapy™ Dual 8™ Cardiac Ablation Catheter used in conjunction with the IBI 1500T6 (USA) Cardiac Ablation Generator is safe and effective for the stated indications under the proposed conditions for use.

12.0 Panel Recommendation

In accordance with the provisions of section 515(c)(2) of the act as amended by the Safe Medical Devices Act of 1990, this PMA was not referred to the Circulatory Systems Devices Panel, an FDA advisory committee, for review and recommendation because the information in the PMA is similar to information previously reviewed by this panel.

13.0 CDRH Decision

CDRH issued an approval order on November 18, 2005.

The applicant's manufacturing facilities were inspected on February 1, 2002, September 23, 2004 and August 25, 2005, and found to be in compliance with the device Quality System Regulation (Part 820).

14.0 Approval Specifications

- Directions for Use: See Final Draft Labeling
- Hazards to Health from Use of the Device: See Indications, Contraindications, Warnings and Precautions, and Adverse Events in the final draft labeling.
- Post-approval Requirements and Restrictions: See Approval Order