SUMMARY OF SAFETY AND EFFECTIVENESS DATA

I. GENERAL INFORMATION

Device Generic Name:	Ophthalmic Excimer Laser System
Device Trade Name:	Keracor® 116 Excimer Laser System
Applicant's Name and Address:	Bausch & Lomb Surgical, Inc. 555 West Arrow Highway Claremont, CA 91711
Date(s) of Panel Recommendation:	None
Premarket Approval Application (PMA) Number:	P970056
Date of Notice of Approval to Applicant:	September 28, 1999

II. INDICATIONS FOR USE

The KERACOR® 116 Excimer Laser System (henceforth to be called KERACOR 116) is indicated for myopic photorefractive keratectomy (PRK) in patients who meet the following criteria:

1. in PRK treatments for the reduction or elimination of myopia between -1.50 to -7.00D of sphere and less than or equal to -4.5D of astigmatism;
2. documented evidence of a change in manifest refraction of less than or equal to 0.50 diopters (in both cylinder and sphere components) for at least one year prior to the date of the pre-operative examination; and,
3. who are 18 years of age or older.

III. CONTRAINDICATIONS

Photorefractive keratectomy treatment should not be performed in patients:

1. with collagen vascular, autoimmune or immunodeficiency diseases;
2. who are pregnant or nursing;
3. with signs of keratoconus; or,

4. who are taking one or both of the following medication: isotretinoin (Accutane), or aminodarone hydrochloride (Cordarone)

IV. WARNINGS AND PRECAUTIONS

The warnings and precautions can be found in the device labeling.

V. DEVICE DESCRIPTION

Specifications

The specifications of the KERACOR 116 excimer laser are as follows:

KERACOR 116 Excimer Laser Specifications	
Laser Type	Argon-Fluoride
Laser Wavelength	193 nanometers
Laser Pulse Duration	18 nanoseconds
Pulse Repetition Rate	10 Hertz
Fluence (at the eye)	120 mJ/cm^2
Range Diaphragm Diameter	0.8 to 7.0 mm

Physical Description

The KERACOR 116 consists of the following primary components/subsystems: laser unit, control unit, and bridge unit. The laser and control units are arranged around a movable patient bed. This patient bed is designed to position the patient with respect to the fixed focal position of the laser optics. The laser unit is positioned on one side of the bed and the computer control unit is positioned on the other side. The optics (both laser and operating microscope optics) are contained in a stable bridge unit that connects the laser and control units.

Laser Unit

The laser unit contains the laser head, the high-voltage system, and the gas system necessary to generate the desired laser energy. It also includes a containment system which ensures that all toxic gases are confined within the laser unit and only nontoxic gas is released to the atmosphere.

Control Unit

The control unit contains the control electronics and a standard MS-DOS based personal computer.

Bridge Unit

The bridge unit contains the optical elements that condition the laser beam to the appropriate characteristics. It also contains the visualization optics (operating microscope) and the position and fixation optics for properly locating and monitoring the progress of the ablation.

VI. ALTERNATIVE PRACTICES AND PROCEDURES

Alternative methods of correcting nearsightedness (myopia) are spectacles, contact lenses, incisional refractive keratotomy, automated lamellar keratoplasty, and LASIK (laser assisted in situ keratomileusis).

VII. MARKETING HISTORY

Over 220 KERACOR 116 lasers have been installed in the following countries since 1992: Argentina, Australia, Austria, Bahrain, Belgium, Brazil, Canada, China, Colombia, Czech Republic, Denmark, Ecuador, France, Germany, India, Iran, Israel, Italy, Japan, Philippines, Portugal, Saudi Arabia, Singapore, Slovakia, South Africa, South Korea, Spain, Switzerland, Syria, Turkey, Turks and Caicos, United States, and Venezuela .

The KERACOR 116 has not been withdrawn from any country or market for any reasons related to safety and effectiveness.

VIII. ADVERSE EFFECTS OF THE DEVICE ON HEALTH

Potential adverse reactions associated with PRK include: loss of best spectacle corrected visual acuity, worsening of patient complaints such as double vision, sensitivity to bright lights, increased difficulty with night vision, fluctuations in vision, increase in intraocular pressure, corneal haze, secondary surgical intervention, corneal infiltrate or ulcer, corneal epithelial defect, corneal edema, retinal detachment, and retinal vascular accidents.

Please refer to the complete listing of adverse events and complications observed during the clinical study which are presented on pages 14-18 of the clinical study section.

IX. SUMMARY OF PRECLINICAL STUDIES

The following preclinical studies were performed:

Functionality Testing – Fluence Test

The fluence test is performed for the purpose of calibrating the excimer laser to ensure the proper beam characteristics and energy of the laser beam. It is performed prior to each treatment to verify beam homogeneity and energy.

The fluence test is performed by placing a small red plate covered with a thin layer of foil into the treatment plane, and then viewing the fluence plate being ablated. The fluence test plates are designed such that when the foil is fully ablated, a homogeneous red endpoint pattern is revealed at the point at which a fluence of 120 mJ/cm^2 is achieved. The purpose is to ablate the silver foil from the surface of the red plate in a uniformly random pattern with a 5 mm circular ablation spot within a predetermined number of pulses (65 $\pm$ 2 pulses).

The homogeneity of the beam is characterized by the ablation patterns observed on the fluence plates. The spatial element of the beam is most clearly observed by the change in color of the fluence plate and the regularity of the ablation surface. In addition to serving as a useful tool for the surgeon prior to treatment, the computer system utilizes the fluence test energy value as the standard against which energy is compared. It is this comparison that enables the computer to decide if the laser energy output is within acceptable limits.

Reliability Testing

This testing is performed to ensure the reliability of components critical to the safety and performance of the excimer laser system. These tests include laserhead lifetime stability testing and shutter life cycle testing.

Lifetime Stability of the Laser Head

The level of energy released by the laser head is, in large part, determined by the lifetime of the ArF gas mix. Gas lifetime has two components: active lifetime and passive lifetime. Active gas lifetime is defined as the number of shots that one gas fill of the laser cavity can produce until the energy drops below 50% of the starting energy level. Passive gas lifetime is defined as the number of days without firing laser pulses that one gas fill will last until the energy drops below 50% of the starting energy level.

After initial setup and adjustment, the laser head is purged and filled with a fresh volume of standard gas mix. The energy output of the laser head is measured. At each measurement point, the pulse energy of the initial pulses is measured as well as the energy measured after 1000 shots were fired. Between measurement points, the laser is switched off until it is re-switched on to take the measurement. Results of this testing demonstrate that the

passive lifetime of the laser gas declines gradually and linearly over a 10-day period.

The laser head manufacturer specifies that the laser head has a passive lifetime of more than seven days and an active lifetime of more than 500,000 shots.

The dynamic lifetime is determined by firing the laser head in cycles of 5,000 shots and measuring laser energy. If after 80 cycles (400,000 shots) the energy drops below 50%, the laser head is rejected. Measuring the energy level before and after a 24-hour period checks the passive lifetime. During the 24-hour period the laser is switched off and not fired. If after 24 hours, the energy level drops more than 10%, the laser head is rejected.

Shutter Life Cycle Testing

To confirm that the electromechanical shutter in the excimer laser system is capable of performing its required function over the lifetime of the laser system, the electromechanical shutter was cycled continuously at two-second intervals using a pulse generator for a total of 200,000 cycles. This is in excess of the expected lifetime of the laser system. The nature, time and reason for any electrical, mechanical or other failure of the shutter mechanism were recorded and the shutter blade was examined for wear at the end of the testing.

There were no cycle failures nor was there any discernible wear of the electromechanical shutter after 200,000 cycles. The results of the testing demonstrated that the shutter is capable of performing its required functions: (1) remaining closed to prevent the emission of laser light, and (2) opening when instructed by the microprocessor, over the expected lifetime of the laser.

Ablation Studies

Ablation studies are designed to characterize the photoablative characteristics of the device and the quality of the ablation patterns. Ablations were performed on PMMA plates of equal dimensions and characteristics. Five ablations of each of the three treatment corrections (with one correction per PMMA plate) were performed using the PRK algorithm. The frequency of the laser was set to 1 Hz. This frequency was selected to reduce the influence of the PMMA debris cloud on the ablation. Gas changes and/or energy adjustments were made between ablations when necessary, to obtain an acceptable fluence test. The ablations were measured using a UBM profilometer.

The data were analyzed by examining the x- and y-axes of the depth and width for all ablation curves generated for each of the three treatments. These ablation curves were compared to the theoretical curves predicted by the software. The results show that the ablation curves generated by the

KERACOR 116 closely approximate the theoretical curves predicted by the software.

Additional Studies

Electrical Safety and Electromagnetic Compatibility Testing

The KERACOR 116 excimer laser system contains a Class IV laser that conforms with the requirements of the Radiological Health and Safety Act codified in the regulations under 21 CFR 1040/10 and 1040.11. In addition, the KERACOR 116 has been certified by the certifying/testing body, Landesgewerbeanstalt Bayern (LGA), as meeting the IEC 601 standards for electrical safety and electromagnetic compatibility.

Software Verification Test

The KERACOR 116 software (version v2.6a) was validated to ensure the adequacy of the software version in controlling and monitoring the functions of the KERACOR 116 excimer laser system. The testing conducted was carried out as a black box, or where necessary, white box tests utilizing the standard input devices of the laser system. If necessary to enter the system (for example, to trigger an error message) only the specific activity described by the individual test was performed. The validation was performed on three different KERACOR 116 excimer laser systems.

X. SUMMARY OF CLINICAL STUDIES

The sponsor performed clinical studies of the KERACOR 116 excimer laser system in the US under the auspices of 4 IDEs: G930115 (low myopia); G930190 (high myopia); G940088 (myopic astigmatism); and, G940119 (LASIK versus PRK and PRK retreatment). From these combined studies, data for the appropriate refractive ranges served as the basis for the approval decision. Specifically, safety and effectiveness outcomes at 9 months postoperative were assessed as stability is reached by that time. Outcomes at 12 months postoperatively were also evaluated for confirmation. The IDE studies are described in detail as follows.

A. STUDY OBJECTIVES

Clinical investigations of the KERACOR 116 Excimer Laser System were conducted to evaluate the safety and effectiveness of the laser in the correction of low to moderate myopia, with accompanying refractive astigmatism, when used in the procedure known as photorefractive keratectomy (PRK).

B. STUDY DESIGN

The study for this submission was a prospective, non-randomized, multi-center clinical evaluation of 714 eyes.

C. INCLUSION AND EXCLUSION CRITERIA

Patients enrolled as study subjects had to have the required amount of myopia and astigmatism; have normal, healthy eyes with visual acuity correctable to at least 20/40; have no previous history of ocular surgery; and be at least 18 years of age. All patients provided written informed consent to become a study subject.

Patients were not permitted to enroll in the Keracor 116 study if they met any of the following exclusion criteria: anterior segment pathology, significant corneal abnormalities; keratoconus; active ocular disease; irregular astigmatism; herpes keratitis; previous intraocular or corneal surgery; and patients who were immunocompromised, pregnant, or who had diabetes, atopy, connective tissue or autoimmune disease.

D. STUDY PLAN, PATIENT ASSESSMENTS, AND EFFICACY CRITERIA

All subjects were expected to return for follow-up examinations: at days 1 and 3, days 5 and 7 (for subjects not completely re-epithelialized at day 3), then at 1, 3, 6, 9 and 12 months.

Subjects were permitted to have second eyes (fellow eyes) treated a minimum of 3 months after treatment of the first eye. In addition, subjects were eligible for retreatment if they met the following criteria: uncorrected visual acuity worse than 20/40; or spherical equivalent refraction of 0.50 D or greater from the intended correction; or uncorrected refractive cylinder of 0.50 D or greater. Retreatment was not permitted until at least 12 months after the initial treatment.

The objective parameters measured during the study included: evaluations of visual acuity (using ETDRS charts), manifest refraction, cycloplegic refraction (at selected visits), intraocular pressure measurements, slit lamp examination and fundus examination (at selected visits). Subjects were also asked to complete a self-evaluation questionnaire at each visit from 1 month on.

The primary efficacy variables for this study were: percent of eyes achieving uncorrected visual acuity (UCVA) of 20/40 or better, percent of eyes within ±1.00 and ±0.50 D of the intended spherical refractive correction, and percent

of eyes with astigmatism correction within 1.00 D of intended correction by vector analysis.

E. STUDY PERIOD, INVESTIGATIONAL SITES, AND DEMOGRAPHICS

1. STUDY PERIOD AND INVESTIGATIONAL SITES

Subjects were treated between September 1993 and October 1995. The database for this included 714 eyes: 460 first eyes and 254 second eyes. There were 16 investigational sites.

2. DEMOGRAPHICS

A total of 714 eyes with a preoperative refraction within the specified range for inclusion were treated. Demographic data stratified by treatment for spherical myopia only and for astigmatic myopia are provided in Table 1:

Table 1
Patient Demographics

Demographics		Spherical Myopia Only		Astigmatic Myopia	
Number of Eyes & Subjects		419 Eyes of 270 Enrolled Subjects		295 Eyes of 190 Enrolled Subjects	
		N	%	N	%
Gender	Male	207	49.4	139	47.1
	Female	212	50.6	156	52.9
Race	White	406	96.9	285	96.6
	Black	3	0.7	3	1.0
	Asian	6	1.4	0	0.0
	Other	3	0.7	6	2.0
	No Data Available	1	0.2	1	0.3
Surgical Eye	Right	226	53.9	151	51.2
	Left	193	46.1	144	48.8
Age	Mean	38.0 (9.5)		42.5 (8.4)	
	Minimum, Maximum	18, 67		19, 62	

F. DATA ANALYSIS AND RESULTS

1. PREOPERATIVE CHARACTERISTICS

Tables 2 and 3 contain summaries of the preoperative acuity and refraction for the spherical myopia and astigmatic myopia patients, respectively.

Table 2
Preoperative Refraction Parameters
Eyes Treated for Spherical Myopia Only

Manifest Refraction	Primary Eyes		Fellow Eyes		Total Eyes	
	N	%	N	%	N	%
Sphere						
1.00-1.99 D	10	4.0	5	2.9	15	3.6
2.00-2.99 D	34	13.7	27	15.8	61	14.6
3.00-3.99 D	31	12.5	18	10.5	49	11.7
4.00-4.99 D	54	21.8	32	18.7	86	20.5
5.00-5.99 D	60	24.2	49	28.7	109	26.0
6.00-7.00 D	59	23.8	40	23.4	99	23.6
Mean (SD)	4.58 (1.52)		4.62 (1.49)		4.60 (1.50)	
Range	1.00 to 7.00		1.25 to 7.00		1.00 to 7.00	
Total	248	100.0	171	100.0	419	100.0
Cylinder						
0.00 D	80	32.3	74	43.3	154	36.8
0.25 D	30	12.1	20	11.7	50	11.9
0.50 D	69	27.8	42	24.6	111	26.5
0.75 D	57	23.0	28	16.4	85	20.3
1.00 D	11	4.4	6	3.5	17	4.1
1.25 D	1	0.4	0	0.0	1	0.2
1.50 D	0	0.0	1	0.6	1	0.2
Mean (SD)	0.32 (0.32)		0.32 (0.33)		0.36 (0.33)	
Range	0.00 to 1.25		0.00 to 1.50		0.00 to 1.50	
Total	248	100.0	171	100.0	419	100.0

Table 3
Preoperative Refraction Parameters
Stratified by Sphere and Cylinder Components
Eyes Treated for Astigmatic Myopia

N = 295

Manifest Sphere	Manifest Cylinder					
Mean (SD): 4.67 (1.77)	0.00-0.99 D	1.00-1.99 D	2.00-2.99 D	3.00-3.99 D	4.00-4.99 D	Total
Range: 0.50 to 7.00	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
0.00-0.99 D	1 (0.3)	0 (0.0)	3 (1.0)	2 (0.7)	0 (0.0)	6 (2.0)
1.00-1.99 D	0 (0.0)	9 (3.1)	6 (2.0)	2 (0.7)	1 (0.3)	18 (6.1)
2.00-2.99 D	2 (0.7)	19 (6.4)	9 (3.1)	2 (0.7)	0 (0.0)	32 (10.8)
3.00-3.99 D	3 (1.0)	23 (7.8)	12 (4.1)	1 (0.3)	3 (1.0)	42 (14.2)
4.00-4.99 D	1 (0.3)	25 (8.5)	12 (4.1)	4 (1.4)	2 (0.7)	50 (16.9)
5.00-5.99 D	4 (1.4)	26 (8.8)	10 (3.4)	9 (3.1)	1 (0.3)	50 (16.9)
6.00-7.00 D	15 (5.1)	62 (21.0)	15 (5.1)	9 (3.1)	2 (0.7)	103 (34.9)
Total	26 (8.8)	164 (55.6)	67 (22.7)	29 (9.8)	9 (3.1)	295 (100.0)

2. POSTOPERATIVE RESULTS

a. Table 4 displays the patient accountability at 12 months. The sponsor's overall accountability, at 91%, exceeds FDA's 80% benchmark.

At 12 months, the cohort available for the effectiveness analysis consisted of 651 eyes. Five retreated eyes were excluded from this PMA cohort. There were 58 eyes lost to follow-up before 12 months.

The safety cohort included all treated eyes.

Table 4
Accountability
All Treated Eyes

Status	Spherical Myopia Only	Astigmatic Myopia	Total
Available for Analysis at ≥ 12 Months n/N (%)	381/419 (90.9)	270/295 (91.5)	651/714 (91.2)
Discontinued* Before 12 Months	4/419 (1.0)	1/295 (0.3)	5/714 (0.7)
Lost to Follow-up Before 12 Months n/N	34/419 (8.1)	24/295 (8.1)	58/714 (8.1)
% Accountability = Available for Analysis ÷ (Enrolled – Discontinued)	381/415 (91.8)	270/294 (91.8)	651/709 (91.8)

N = Total eyes enrolled
*Discontinued = Exited due to Keracor-laser retreatment or non-Keracor-laser retreatment

b. Stability of outcome

In the 9-12 months window, 94.2% of eyes treated for spherical myopia and 96.1% of eyes treated for astigmatic myopia experienced a change of MRSE not exceeding 1.0D. The assessment of the efficacy was therefore performed using the outcomes of the 225 eyes (spherical myopia) and 204 eyes (astigmatic myopia) evaluable at 9-12 months.

Table 5
Stability of Manifest Refraction Spherical Equivalent
Eyes Treated for Spherical Myopia Only
Consistent Cohort (N=225 eyes)

Change in Spherical Refraction	Between 1 & 3 Months	Between 3 & 6 Months	Between 6 & 9 Months	Between 9 & 12 Months
Change of MRSE by ≤ 1.00 D				
N/N* (%)	197/225 (87.6)	207/224 (92.4)	211/224 (94.2)	212/225 (94.2)
95% CI for %	(83.3, 91.8)	(88.8, 96.0)	(91.2, 97.2)	(91.2, 97.2)
Change of MRSE (Paired Differences) in Diopters				
Mean	-0.157	-0.068	-0.026	0.022
SD	0.766	0.626	0.545	0.511
95% CI for Mean	(-0.256, -0.057)	(-0.148, 0.013)	(-0.096, 0.044)	(-.046, 0.089)

Table 6
Stability of Manifest Refraction Spherical Equivalent
Eyes Treated for Astigmatic Myopia
Consistent Cohort (N=204 eyes)

Change in Spherical Refraction	Between 1 & 3 Months	Between 3 & 6 Months	Between 6 & 9 Months	Between 9 & 12 Months
Change of MRSE by ≤ 1.00 D				
N/N* (%)	177/201 (88.1)	195/203 (96.1)	196/204 (96.1)	193/204 (94.6)
95% CI for %	(83.7, 92.5)	(93.4, 98.7)	(93.3, 98.9)	(91.6, 97.7)
Change of MRSE (Paired Differences) in Diopters				
Mean	-0.246	-0.016	-0.088	0.006
SD	0.746	0.478	0.484	0.578
95% CI for Mean	(-0.349, -0.143)	(-0.077, 0.046)	(-0.152, -0.023)	(-0.074, 0.085)

c. Effectiveness Outcomes

The analysis of effectiveness was based on the 333 eyes (spherical myopia) and 246 eyes (astigmatic myopia) and evaluable at the 9 months stability time point. Key efficacy outcomes are presented in tables 7 and 8. The effectiveness at powers above –7.00 D was found to be insufficient to justify approval beyond the –7.00 D power level.

Table 7
Summary of Key Safety and Effectiveness Variables
At the Point of Stability (Month 9) Stratified by Preoperative MRSE/MRSPH*
All Eyes Treated for Spherical Myopia Only

Key Safety & Effectiveness Variables	0.50 to 2.00 D† n/N (%)	2.01 to 3.00 D n/N (%)	3.01 to 4.00 D n/N (%)	4.01 to 5.00 D n/N (%)	5.01 to 6.00 D n/N (%)	6.01 to 7.00 D n/N (%)
Effectiveness Variables						
UCVA 20/20 or better	9/12 (75.0%)	25/43 (58.1%)	14/33 (42.4%)	27/68 (39.7%)	41/94 (43.6%)	40/83 (48.2%)
UCVA 20/40 or better	11/12 (91.7%)	39/43 (90.7%)	27/33 (81.8%)	65/68 (95.6%)	83/94 (88.3%)	63/83 (75.9%)
MRSE* ± 0.50 D	11/12 (91.7%)	27/43 (62.8%)	16/33 (48.5%)	38/68 (55.9%)	55/94 (58.5%)	43/83 (51.8%)
MRSE* ± 1.00 D	11/12 (91.7%)	37/43 (86.0%)	29/33 (87.9%)	56/68 (82.4%)	71/94 (75.5%)	58/83 (69.9%)
MRSE* ± 2.00 D	12/12 (100.0%)	43/43 (100.0%)	33/33 (100.0%)	66/68 (97.1%)	90/94 (95.7%)	78/83 (94.0%)
Safety Variables						
Loss of ≥ 2 lines BSCVA	0/12 (0.0%)	2/43 (4.7%)	1/33 (3.0%)	5/67 (7.5%)	1/94 (1.1%)	2/83 (2.4%)
Loss of > 2 lines BSCVA	0/12 (0.0%)	0/43 (0.0%)	0/33 (0.0%)	0/67 (0.0%)	0/94 (0.0%)	0/83 (0.0%)
BSCVA worse than 20/40	0/12 (0.0%)	0/43 (0.0%)	0/33 (0.0%)	0/67 (0.0%)	0/94 (0.0%)	0/83 (0.0%)
Increase > 2 D cylinder‡	0/12 (0.0%)	0/43 (0.0%)	0/33 (0.0%)	0/68 (0.0%)	0/94 (0.0%)	0/83 (0.0%)
BSCVA worse than 20/25 if 20/20 or better preoperatively§	0/11 (0.0%)	0/38 (0.0%)	0/30 (0.0%)	0/61 (0.0%)	1/86 (1.2%)	1/74 (1.4%)

N = Number of received CRFs with non-missing values at each visit.

* Preoperative MRSE (manifest spherical equivalent) was used for eyes treated for spherical myopia only, and preoperative MRSPH (manifest sphere) was used for eyes treated for astigmatic myopia.

† Two eyes treated for astigmatic myopia and back for the 9-month visit had a preoperative sphere less than -1.00 D (-0.50 & -0.75 D).

‡ For eyes treated for spherical myopia only.

§ For eyes with BSCVA 20/20 or better preoperatively.

Table 8
Summary of Key Safety and Effectiveness Variables
At the Point of Stability (Month 9) Stratified by Preoperative MRSE/MRSPH*
All Eyes Treated for Astigmatic Myopia

Key Safety & Effectiveness Variables	0.50 to 2.00 D† n/N (%)	2.01 to 3.00 D n/N (%)	3.01 to 4.00 D n/N (%)	4.01 to 5.00 D n/N (%)	5.01 to 6.00 D n/N (%)	6.01 to 7.00 D n/N (%)
Effectiveness Variables						
UCVA 20/20 or better	13/18 (72.2%)	7/28 (25.0%)	16/35 (45.7%)	14/40 (35.0%)	22/52 (42.3%)	32/73 (43.8%)
UCVA 20/40 or better	18/18 (100.0%)	24/28 (85.7%)	32/35 (91.4%)	31/40 (77.5%)	45/52 (86.5%)	63/73 (86.3%)
MRSE* ± 0.50 D	11/18 (61.1%)	11/28 (39.3%)	17/35 (48.6%)	14/40 (35.0%)	22/52 (42.3%)	25/73 (34.2%)
MRSE* ± 1.00 D	16/18 (88.9%)	20/28 (71.4%)	28/35 (80.0%)	23/40 (57.5%)	39/52 (75.0%)	53/73 (72.6%)
MRSE* ± 2.00 D	18/18 (100.0%)	28/28 (100.0%)	33/35 (94.3%)	38/40 (95.0%)	48/52 (92.3%)	70/73 (95.9%)
Safety Variables						
Loss of ≥ 2 lines BSCVA	0/18 (0.0%)	0/28 (0.0%)	2/35 (5.7%)	3/40 (7.5%)	2/52 (3.8%)	7/73 (9.6%)
Loss of > 2 lines BSCVA	0/18 (0.0%)	0/28 (0.0%)	0/35 (0.0%)	0/40 (0.0%)	0/52 (0.0%)	1/73 (1.4%)
BSCVA worse than 20/40	0/18 (0.0%)	0/28 (0.0%)	0/35 (0.0%)	0/40 (0.0%)	0/52 (0.0%)	1/73 (1.4%)
Increase > 2 D cylinder‡	NA	NA	NA	NA	NA	NA
BSCVA worse than 20/25 if 20/20 or better preoperatively§	0/15 (0.0%)	0/23 (0.0%)	1/28 (3.6%)	1/35 (2.9%)	1/40 (2.5%)	5/64 (7.8%)

N = Number of received CRFs with non-missing values at each visit.

* Preoperative MRSE (manifest spherical equivalent) was used for eyes treated for spherical myopia only, and preoperative MRSPH (manifest sphere) was used for eyes treated for astigmatic myopia.

† Two eyes treated for astigmatic myopia and back for the 9-month visit had a preoperative sphere less than -1.00 D (-0.50 & -0.75 D).

‡ For eyes treated for spherical myopia only.

§ For eyes with BSCVA 20/20 or better preoperatively.

Correction of Spherical Component

At 9 months, 57.2% (spherical myopia) and 40.7% (astigmatic myopia) of eyes were within +0.50 D of the intended spherical correction and 78.7% (spherical myopia) and 72.8 % (astigmatic myopia) were within +1.00 D. Although there are no specific benchmarks for only the spherical component, these results are within the benchmarks for MRSE and are therefore acceptable.

d. Safety Outcomes

The analysis of safety was based on the 714 eyes that have had the 12 months exam. The key safety outcomes for this study are presented in tables 9 and 10, with an analysis of safety at point of stability reported in tables 7 and 8. Overall, the device was deemed reasonably safe.

Table 9
Summary of Key Safety Variables Over Time
All Eyes Treated for Spherical Myopia Only

Key Safety Variables	1 Month n/N (%)	3 Months n/N (%)	6 Months n/N (%)	9 Months n/N (%)	12 Months n/N (%)	≥ 12 Months* n/N (%)
Loss of ≥ 2 lines BSCVA	90/382 (23.6%)	19/376 (5.1%)	10/367 (2.7%)	12/334 (3.6%)	4/327 (1.2%)	12/381 (3.1%)
Loss of > 2 lines BSCVA	31/382 (8.1%)	5/376 (1.3%)	2/367 (0.5%)	0/334 (0.0)	0/327 (0.0)	0/381 (0.0)
BSCVA worse than 20/40	13/382 (3.4%)	3/376 (0.8%)	1/367 (0.3%)	0/334 (0.0)	0/327 (0.0)	0/381 (0.0)
Increase > 2 D cylinder‡	3/386 (0.8%)	1/376 (0.3%)	3/368 (0.8%)	0/335 (0.0)	0/328 (0.0)	2/382 (0.5%)
BSCVA worse than 20/25 if 20/20 or better preoperatively§	44/339 (13.0%)	8/333 (2.4%)	3/324 (0.9%)	2/302 (0.7%)	0/291 (0.0)	2/340 (0.6%)

N = Number of received CRFs with non-missing values at each visit.

* The first non-missing response reported from 12 to 24 months for the effectiveness variables, and the worst response reported from 12 to 24 months for the safety variables.

† MRSE = Manifest Spherical Equivalent.

‡ For eyes treated for spherical myopia only.

§ For eyes with BSCVA 20/20 or better preoperatively.

Table 10
Summary of Key Safety Variables Over Time
All Eyes Treated for Astigmatic Myopia

Key Safety Variables	1 Month n/N (%)	3 Months n/N (%)	6 Months n/N (%)	9 Months n/N (%)	12 Months n/N (%)	≥ 12 Months* n/N (%)
Safety Variables						
Loss of ≥ 2 lines BSCVA	45/279 (16.1%)	19/281 (6.8%)	6/260 (2.3%)	13/244 (5.3%)	8/236 (3.4%)	12/268 (4.5%)
Loss of > 2 lines BSCVA	12/279 (4.3%)	2/281 (0.7%)	2/260 (0.8%)	1/244 (0.4%)	0/236 (0.0)	1/268 (0.4%)
BSCVA worse than 20/40	7/279 (2.5%)	0/281 (0.0)	0/260 (0.0)	1/244 (0.4%)	0/236 (0.0)	0/268 (0.0)
Increase > 2 D cylinder‡	NA	NA	NA	NA	NA	NA
BSCVA worse than 20/25 if 20/20 or better preoperatively§	21/235 (8.9%)	11/234 (4.7%)	3/218 (1.4%)	8/203 (3.9%)	2/197 (1.0%)	5/227 (2.2%)

N = Number of received CRFs with non-missing values at each visit.

* The first non-missing response reported from 12 to 24 months for the effectiveness variables, and the worst response reported from 12 to 24 months for the safety variables.

† MRSE = Manifest Spherical Equivalent.

‡ For eyes treated for spherical myopia only.

§ For eyes with BSCVA 20/20 or better preoperatively.

Table 11 presents a summary of adverse events. The benchmark for each adverse event is a rate of less than 1 % per event. The observed adverse events and complications from this specific study did not appear to be different from those noted previously. Table 12 presents complications at any postoperative visit and Table 13 presents the change in patient symptoms at ≥ 12 months postoperative from baseline.

Table 11
Cumulative Adverse Events
All Treated Eyes

Adverse Event	n/N (%)
Loss of ≥ 2 lines BSCVA at 6 months or later	53/714 (7.4%)
Loss of 2 lines BSCVA at 6 months or later	7/714 (1.0%)
BSCVA worse than 20/40 at 6 months or later	5/714 (0.7%)
BSCVA worse than 20/25 at 6 months or later if 20/20 or better preoperatively	21/617 (3.4%)
Haze ≥ trace with loss of BSCVA > 2 lines at 6 months or later	4/714 (0.6%)
Increased manifest refractive astigmatism > 2.0 D	2/419 (0.5%)
Postoperative IOP increase from preop > 10 mm Hg	16/707 (2.3%)
Postoperative IOP > 25 mm Hg	23/711 (3.2%)

n = # eyes with corresponding safety event

N = # eyes with non-missing measurement

Table 12
Complications at
Any Postoperative Visit

Adverse Event	n/N (%)
Blepharitis	2/714 (0.3%)
Blurry vision	5/714 (0.7%)
Burning	12/714 (1.7%)
Conjunctivitis	7/714 (1.0%)
Corneal epithelial defect	3/714 (0.4%)
Corneal scarring	8/714 (1.1%)
Dry eye	7/714 (1.0%)
Foreign body sensation	29/714 (4.1%)
Ghosting/double image	15/714 (2.1%)
Glare	81/714 (11.3%)
Halos	34/714 (4.8%)
Haze	2/714 (0.3%)
Headaches	4/714 (0.6%)
IOP increase	8/714 (1.1%)
Iritis	29/714 (4.1%)
Light sensitivity	17/714 (2.4%)
Night driving	32/714 (4.5%)
Pain	4/714 (0.6%)
Patient discomfort	23/714 (3.2%)
Recurrent erosion	3/714 (0.4%)
Redness	6/714 (0.8%)
Tearing	5/714 (0.7%)
Undercorrection	5/714 (0.7%)

n = # eyes with corresponding safety event

N = # eyes with non-missing measurement

Table 13
Change in Patient Symptoms at ≥ 12 Months Postoperative from Baseline
All Treated Eyes

Patient Symptoms	n/N (%)		
	Better	No Change	Worse
Light Sensitivity	81/597 (13.6%)	391/597 (65.5%)	115/597 (19.3%)
Headaches	76/597 (12.7%)	470/597 (78.7%)	51/597 (8.5%)
Pain	15/597 (2.5%)	520/597 (87.1%)	62/597 (10.4%)
Redness	53/597 (8.9%)	496/597 (83.1%)	48/597 (8.0%)
Tearing	19/597 (3.2%)	541/597 (90.6%)	37/597 (6.2%)
Burning	33/597 (5.5%)	508/597 (85.1%)	56/597 (9.4%)
Gritty feeling	20/597 (3.4%)	484/597 (81.1%)	93/597 (15.6%)
Glare	51/597 (8.5%)	369/597 (61.8%)	183/597 (30.7%)
Halos	39/597 (6.5%)	392/597 (65.7%)	166/597 (27.8%)
Night driving vision	87/597 (14.6%)	278/597 (46.6%)	232/597 (38.9%)
Allergies	4/597 (0.7%)	592/597 (99.2%)	1/597 (0.2%)
Astigmatism	0/597 (0.0%)	590/597 (98.8%)	7/597 (1.2%)
Blurry vision	8/597 (1.3%)	534/597 (89.4%)	55/597 (9.2%)
Conjunctivitis	0/597 (0.0%)	596/597 (99.8%)	1/597 (0.2%)
Corneal abrasion	0/597 (0.0%)	595/597 (99.5%)	2/597 (0.3%)
Depth perception	1/597 (0.2%)	596/597 (99.8%)	0/597 (0.0%)
Discharge	1/597 (0.2%)	592/597 (99.2%)	4/597 (0.7%)
Double vision	0/597 (0.0%)	582/597 (97.5%)	15/597 (2.5%)
Dry eye	10/597 (1.7%)	540/597 (90.5%)	47/597 (7.9%)
Edema	1/597 (0.2%)	596/597 (99.8%)	0/597 (0.0%)
Eye strain	1/597 (0.2%)	593/597 (99.3%)	3/597 (0.5%)
Floaters	0/597 (0.0%)	588/597 (98.5%)	2/597 (0.3%)
Ghosting	1/597 (0.2%)	588/597 (98.5%)	8/597 (1.3%)
Hordeolum	0/597 (0.0%)	596/597 (99.8%)	1/597 (0.2%)
Infection	0/597 (0.0%)	595/597 (99.7%)	2/597 (0.3%)
Involuntary eye movement	1/597 (0.2%)	596/597 (99.8%)	0/597 (0.0%)
Itching	5/597 (0.8%)	587/597 (98.3%)	7/597 (1.2%)
Monocular double vision	2/597 (0.3%)	592/597 (99.1%)	2/597 (0.3%)
Night vision	1/597 (0.2%)	592/597 (99.2%)	4/597 (0.7%)
Starburst	0/597 (0.0%)	592/597 (99.2%)	5/597 (0.8%)
Twitch	1/597 (0.2%)	596/597 (99.8%)	0/597 (0.0%)

N = Number of received Self-evaluation Forms with non-missing values at both preop. & ≥ 12 months visits

e. Retreatment

Table 14 provides a summary of safety and effectiveness data on all retreated eyes. All retreatment procedures were performed at least 12 months after the initial treatment. There were a total of 66 retreatments. There were no major safety concerns for these retreated eyes. FDA does not have enough data to form any definitive conclusions regarding retreatment outcomes with this device because of the low number of retreatments.

Table 14
Retreatment Summary
All Retreated Eyes

Summary Endpoints	Eyes Treated for Spherical Myopia Only n/N (%)	Eyes Treated for Astigmatic Myopia n/N (%)
Retreatment Rate, n/All Treated Eyes (%)	29/419 (6.9%)	37/295 (12.5%)
Key Effectiveness at the Last Available Postoperative Exam After Retreatment		
UCVA 20/20 or better	12/29 (41.4%)	16/37 (43.2%)
UCVA 20/40 or better	25/29 (86.2%)	33/37 (89.2%)
MRSE* ± 0.50 D	16/29 (55.2%)	24/37 (64.9%)
MRSE* ± 1.00 D	24/29 (82.8%)	33/37 (89.2%)
MRSE* ± 2.00 D	27.29 (93.1%)	37/37 (100.0%)
MRCYL* ± 0.50 D	NA	22/37 (59.5%)
MRCYL* ± 1.00 D	NA	33/37 (89.2%)
MRCYL* ± 2.00 D	NA	37/37 (100.0%)
Cumulative Key Safety After Retreatment		
Loss of ≥ 2 lines BSCVA at 6 months or later†	2/29 (6.9%)	3/37 (8.1%)
Loss of >2 lines BSCVA at 6 months or later†	0/29 (0.0%)	0/37 (0.0%)
BSCVA worse than 20/40 at 6 months or later†	0/29 (0.0%)	0/37 (0.0%)
BSCVA worse than 20/25 at 6 months or later if 20/20 or better preoperatively†	2/28 (7.1%)	2/30 (6.7%)
Haze ≥ trace with loss of BSCVA > 2 lines at 6 months or later†	0/29 (0.0%)	0/37 (0.0%)
Increased manifest refractive astigmatism > 2.0 D‡	0/29 (0.0%)	N/A
Postoperative IOP increase from preop > 10 mm Hg	0/26 (0.0%)	1/37 (2.7%)
Postoperative IOP > 25 mm Hg	0/29 (0.0%)	1/37 (2.7%)
Adverse Event Reports/Complications at Any Postoperative Visits After Retreatment		
Central Island	0/29 (0.0%)	1/37 (2.7%)
Dry Eye	0/29 (0.0%)	1/37 (2.7%)
Glare	0/29 (0.0%)	1/37 (2.7%)
Patient Discomfort	1/29 (3.4%)	0/37 (0.0%)

N=Number of retreated eyes

*MRSE – Manifest sphere. MRCYL – Manifest cylinder

†For eyes without visits ≥ 6 months or eyes with visits ≥ 6 months but missing BSCVA, the last non-missing BSCVA was carried forward.

‡For eyes treated for spherical myopia only. The timeframe is "6 months or later."

XI. CONCLUSIONS DRAWN FROM THE CLINICAL STUDY

The data in this application supports reasonable assurance of safety and efficacy of this device for the treatment of myopic photorefractive keratectomy (PRK) with or without astigmatism when used in accordance with the indications for use.

XII. 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 Ophthalmic Devices Panel, an FDA advisory committee, for review and recommendation because the information in the PMA substantially duplicates information previously reviewed by this panel.

XIII. CDRH DECISION

CDRH issued an approval order on September 28, 1999. The applicant's manufacturing facility was inspected on May 8, 1998 and was found to be in compliance with the device Quality System Regulation.

XIV. APPROVAL SPECIFICATIONS

Directions for use: See labeling.

Hazards to Health from Use of the Device: See Indications, Contraindications, Warnings, Precautions, and Adverse Events in the labeling.

Post-approval Requirements and Restrictions: See approval order.