SUMMARY OF SAFETY AND EFFECTIVENESS DATA (SSED)

I. GENERAL INFORMATION

Device Generic Name:	Insulin infusion pump to be used with a continuous glucose monitoring system
Device Trade Name:	Animas Vibe System
Device Procode:	OYC, MDS
Applicant's Name and Address:	Animas Corporation 200 Lawrence Drive West Chester, PA 19380
Date(s) of Panel Recommendation:	None
Premarket Approval Application (PMA) Number:	P130007
Date of FDA Notice of Approval:	November 25, 2014
Priority Review:	*Not applicable*

The Animas® Vibe™ System consists of the Animas® Vibe™ Insulin Pump paired with the Dexcom G4 PLATINUM Sensor and Transmitter. For more information about the Dexcom G4 PLATINUM System (P120005), please see the CDRH website.

II. INDICATIONS FOR USE

The Animas® Vibe™ System consists of the Animas® Vibe™ Insulin Pump paired with the Dexcom G4 PLATINUM Sensor and Transmitter.

The Animas® Vibe™ Insulin Pump is indicated for continuous subcutaneous insulin infusion for the management of insulin-requiring diabetes. It can be used solely for continuous insulin delivery and as part of the Animas® Vibe™ System to receive and display continuous glucose measurements from the Dexcom G4 PLATINUM Sensor and Transmitter.

The Animas® Vibe™ System's continuous glucose monitoring (CGM) is indicated for detecting trends and tracking patterns in persons (age 18 and older) with diabetes, and is intended to complement, not replace, information obtained from standard home glucose monitoring devices. CGM aids in the detection of episodes of hyperglycemia and hypoglycemia, facilitating both acute and long-term therapy adjustments, which may minimize these excursions. Interpretation of results from the Dexcom G4 PLATINUM

Sensor and Transmitter should be based on the trends and patterns seen with several sequential readings over time.

The System is intended for single patient use and requires a prescription.

III. CONTRAINDICATIONS

Contraindications for using the Animas® Vibe™ Insulin Pump
Insulin pump therapy is not recommended for people with diabetes who are unwilling or unable to:
• Test their blood glucose (BG) levels four to six times per day or as recommended by their Healthcare Professional (HCP).
• See their HCP regularly.
• Respond to pump alerts, warnings, and alarms because they are visually or hearing impaired.
Not following these guidelines will make it hard for you to determine how much insulin you need based on your current health status and the foods you eat. Not seeing your HCP on a regular basis will not allow them to make adjustments to your pump settings and diabetes treatment plan that would be beneficial to your health. Not being able to respond to pump notifications means you may not be aware of certain health conditions or problems with your pump that require your attention.

Contraindications for using the Dexcom G4 PLATINUM Sensor and Transmitter
• The Dexcom G4 PLATINUM Sensor and Transmitter must be removed prior to Magnetic Resonance Imaging (MRI), computerized tomography (CT) scan, or diathermy treatment. The Dexcom G4 PLATINUM Sensor and Transmitter have not been tested during MRI or CT scans or with diathermy treatment, and it is unknown if there are safety or performance issues.
• Taking acetaminophen-containing medications while wearing the Sensor may falsely raise your Sensor glucose readings. The level of inaccuracy depends on the amount of acetaminophen active in your body.

IV. WARNINGS AND PRECAUTIONS

The warnings and precautions can be found in the Animas Vibe System labeling.

V. DEVICE DESCRIPTION

The Animas Vibe System ("Vibe System") consists of the Animas Vibe Insulin Pump ("The Pump") and Dexcom G4 Platinum CGM System. The Vibe System includes an insulin infusion pump, designed to communicate via Radio Frequency (RF) telemetry with the Dexcom CGM transmitter ("the Transmitter") to display CGM information in addition to infusion pump data. The insulin infusion pump delivers insulin through an infusion set for continuous subcutaneous insulin infusion for the management of insulin-requiring

diabetes. The Dexcom G4 CGM System sensor ("the Sensor") provides continuous measurements of glucose in the tissue over the range of 40 to 400 mg/dL for up to seven days of use measuring and displaying glucose values and trends for patients with diabetes mellitus. The Vibe System provides glucose trends, alerts and a low glucose alarm.

Description of System Components

The Animas Vibe System is comprised of the following components:

Animas Vibe Insulin Pump

The Animas Vibe Insulin Pump delivers insulin through an infusion set for continuous subcutaneous insulin infusion for the management of insulin-requiring diabetes.

The Animas® Vibe™ Insulin Pump is an external cartridge (syringe) pump and delivery system for ambulatory use by patients with insulin requiring diabetes who would benefit from a continuous insulin infusion process. The pump delivers a prescribed dosage of insulin as a single programmable bolus or at multiple programmable basal rates.

In addition to CGM data, the Animas® Vibe™ Insulin Pump will also display established Animas platform insulin-delivery information: set up information, dosage history, alarms, error and warning messages, device status and self-test capabilities. The Animas® Vibe™ Insulin Pump will not use the continuous glucose monitoring (CGM) data to calculate insulin doses. The CGM data is being provided on the pump screen only as a convenience to the user.

The Animas® Vibe™ Insulin Pump consists of the following subsystems:
- A disposable insulin cartridge for storage of insulin.
- Battery compartment for holding a battery (the pumps energy source).
- Electronics, drive mechanism, software and display which form the core of the pump.

The insulin cartridge is a proprietary syringe comprised of a barrel and a plunger. The cartridge is filled with insulin by the user and is placed in a dedicated housing inside the pump. Within this housing, the cartridge plunger interfaces with a piston, a component of the pump drive mechanism. During the pump delivery sequence, a brushless dc motor drives a speed-reducing gear train and precision lead screw. The lead screw's rotational motion is translated to a linear motion by the (non-rotating) piston. The forward motion by the piston applies a force to the cartridge plunger, which results in the delivery of insulin into the infusion set to the patient via the cannula. The volume of insulin delivered is directly dependent on the displacement of the plunger.

The Animas® Vibe™ Insulin Pump is a prescription device intended for home use and has been designed to withstand the environment typically seen by the patient in the home environment. The Animas® Vibe™ Insulin Pump includes a light emitting diode color display with an adjustable brightness. The design provides protection against fluid ingress (rated IPX8) and has also been designed to conform to relevant electromagnetic compatibility, drop-testing and electrostatic discharge (ESD) standards for performance in the home environment.

The pump software provides the intelligence for key operational functions such as user interface, error monitoring, status reporting and history recording. A glucose and RF engine are also included in the pump electronics to capture process and display CGM sensor signals and information.

Dexcom G4 PLATINUM Sensor

The Dexcom G4 Platinum Sensor is comprised of a sensor applicator, an adhesive pad and transmitter mount and the sensor probe. The G4 Sensor is a sterile device inserted by the user into the abdominal subcutaneous tissue using the applicator. The applicator is adhered to the surface of the skin with a standard medical grade adhesive pad. The applicator contains a 26-gauge introducer needle that contains the sensor probe. The needle is not exposed, or even visible, to the user during the insertion process. After deployment of the introducer needle, the needle is retracted back into the applicator. The applicator is then detached and disposed by the user, exposing a transmitter mount ready for placement of the transmitter.

The sensor probe remains beneath the surface of the skin and uses the enzyme glucose oxidase to convert the glucose in the interstitial fluid around the sensor into an electrical current proportional to the ambient glucose concentration The sensor continuously measures glucose in the interstitial fluid every five minutes. The flexible sensor has an adhesive to adhere the sensor to the skin. The sensor that is adhered to the skin is replaced every seven days.

The Vibe Pump has internally programmed algorithms to receive the wireless sensor signal from the Transmitter and convert the Sensor measured signal to a reading in mg/dL. The Vibe Pump contains embedded software that drives the Pump user interface and signal processing required for glucose reading calculations, trend information displays, alerts and alarms, and signal processing algorithms. The Vibe Pump also contains calibration and signal processing algorithms required to convert the Sensor's electrical signal to glucose values in mg/dL that can be displayed to the user.

Calibrations are performed twice daily by the patient using standard commercially-available blood glucose meter devices and entered manually by the patient into the Animas Vibe insulin pump through a data entry menu. After calibrating the system, the Pump automatically displays the current glucose value, trend graphs of recent glucose values and rate of change arrows once every five minutes. The Animas Vibe Insulin Pump also contains circuitry to provide audible or vibratory alerts for high and low glucose values. The configurable pump High and Low Glucose Alerts can be set by the user in consultation with their health care team to provide warnings when their current glucose level is outside of their target range. Dashed lines on the receiver screen indicate the current alert level settings. The user can configure the Pump to provide audible, vibratory or combined audible and vibratory alerts. The pump also contains a non-configurable low glucose alarm at 55 mg/dL to provide users additional warning of hypoglycemia.

The Vibe System has proprietary algorithms to check for the integrity of the continuous glucose monitoring signal. If the System detects a problem with the Sensor signal or determines that the calibration is beyond an expected value, then the pump will not display a glucose value until the signal quality or calibration has been restored to an acceptable level.

Dexcom G4 Platinum Transmitter

The Dexcom G4 CGM Transmitter is a miniature radio transmitter operating at an internationally-accepted radio frequency. After sensor insertion and removal of the applicator, the user manually places the G4 CGM Transmitter into the transmitter mount on the adhesive pad already attached to the skin. The Transmitter contains all the electrical circuitry necessary for the operation of the electrochemical sensor and also all the radio frequency circuitry necessary to transmit the sensor signal to the receiver in the pump. The transmitter collects the electrical current from the sensor and transmits the sensor signal wirelessly to the Animas Vibe Insulin Pump at 5 minute intervals. The Transmitter is programmed with a unique identification serial number that is manually entered into the corresponding pump by the user in order to establish a secure wireless communication link between the two hardware components. The Transmitter is reusable and contains non-replaceable batteries which allow the device to be used by a single user for the lifetime of the encased batteries, which is typically 6 months from initial use. The Transmitter is re-usable for six months. The transmission distance is at least 12 feet.

Accessories

The following accessories are compatible with the Animas Vibe System:

Infusion Set	Model Numbers
Infusion set with standard luer connector and insulin-compatible tubing	Various models available
Pump Accessories	
Pump Skins	100-495-00, 100-495-01, 100-495-02, 100-495-03, 100-495-04, 100-495-05, 100-495-06, 100-495-07
Bra Pocket	100-023-00, 100-023-01
Low Profile Clip	100-195-01
Pump Supplies	
Lithium Batteries (1.5V)	100-155-00
Cartridges	100-124-01
Battery cap	100-158-01
Cartridge cap	100-159-01

VI. ALTERNATIVE PRACTICES AND PROCEDURES

There are several other alternatives for the control of diabetes. Control of diabetes can be achieved through a combination of methods and behaviors. Self-behaviors include healthy eating, taking medications, as appropriate, and being active. Persons with diabetes may also administer insulin by injection or by using other insulin infusion

pumps as prescribed by his/her physician. Methods of controlling glucose levels (glycemic control) have been shown to reduce severe diabetes-related complications. Methods of monitoring glycemic control include periodic measurement of Hemoglobin A1c (HbA1c), which reflects average blood glucose levels over a three month period. Self-monitoring of blood glucose using glucose meters and test strips provides quantitative measurements of fingerstick blood glucose at a single point in time for patients and their healthcare providers to monitor the effectiveness of glycemic control and make more immediate treatment modifications.

Each alternative has its own advantages and disadvantages. A patient should fully discuss these alternatives with his/her physician to select the method that best meets expectations and lifestyle.

VII. MARKETING HISTORY

The Animas Vibe System has been commercially sold outside the United States beginning in 2011 in the following countries; Netherlands, Germany, the United Kingdom, Australia, New Zealand, Canada, Czech Republic, Austria, Hungary, Italy, France, Denmark, Sweden and Norway.

The device has not been withdrawn from marketing for any reason related to safety or effectiveness.

VIII. POTENTIAL ADVERSE EFFECTS OF THE DEVICE ON HEALTH

Below is a list of the potential adverse effects (e.g., complications) associated with the use of the device.

Potential device-related non-serious events related to CGM or insulin pump use include:

- Skin irritation or redness
- Infection
- Pain or discomfort
- Bruising
- Edema
- Rash
- Bleeding
- Allergic reaction to adhesives
- Hypoglycemia from over-delivery of insulin
- Hyperglycemia and ketosis possibly leading to ketoacidosis due to pump malfunction, or problems with the cannula, needle, or insulin infusion set tubing resulting in cessation of insulin delivery
- Loss of communication between the pump and the sensor resulting in CGM values, alarms, and alerts not being available to the user
- Catheter occlusion resulting in missed insulin dosing

- Catheter dislodgement or fracture during infusion set insertion resulting in injury and/or inability to administer insulin
- Failures of the infusion set or at infusion site resulting in inability to administer insulin
- Mechanical or battery failures resulting in interruptions in insulin delivery or incorrect insulin delivery

Sensor breakage with fragments retained under the skin and catheter fracture during infusion set insertion are potential procedure-related complication. Based on post-market experience with similar devices and the results observed in this clinical study, the occurrence and severity of these events do not raise major concerns.

One potential risk of combining the CGM and the pump is that the user might be more inclined to use the CGM data in an unapproved way to determine their insulin dose. Inaccurate sensor results, if used to make dosing decisions, may lead to hypo- or hyperglycemia. However, no further complications are expected due to the pump being combined with the CGM as a system beyond the potential complications of the pump or CGM alone.

Like other insulin pumps, there is an inherit risk that patients who do not use the system as instructed (nonadherence) could harm themselves. Patients should be informed that sensor interstitial glucose values should not be used to make insulin dose decisions and that all threshold alerts and alarms should be confirmed with a blood glucose measurement.

The risks of actions taken based on false positive hyperglycemic readings include inappropriate or excessive administration of insulin and failure to treat hypoglycemia. These inappropriate treatments could result in or prolong hypoglycemia and result in seizures, loss of consciousness, or death. The risks of actions taken based on false positive hypoglycemic readings include failure to administer insulin and failure to treat hyperglycemia. False positive high alerts and low alerts and alarms may increase the number of unplanned blood glucose checks; and disrupt patient activity and sleep. If the false positive rate is too high it can result in 'alarm fatigue' and patients may deactivate these alerts/alarms.

The risks of actions taken based on false negative hyperglycemic readings include failure to administer or insufficient administration of insulin and inappropriate administration of extra carbohydrate. These inappropriate treatments could prolong or induce hyperglycemia. The risks of actions taken based on false negative hypoglycemic readings include inappropriate administration of insulin or failure to administer or insufficient administration of extra carbohydrate. These inappropriate treatments could result in or prolong hypoglycemia and result in seizures, loss of consciousness, or death. False negative high alerts and low alerts and alarms will prevent the patient from having the opportunity to perform unplanned blood glucose tests and treat as instructed by their healthcare providers.

The CGM component is to be used only for tracking and trending glucose levels. The risk related to either an inaccurate sensor value outside of the patient's normal range or a false alert or alarm is the risk of performing an unnecessary additional blood glucose test to confirm the erroneous sensor reading. The risk of medical harm may be mitigated through labeling which emphasizes that patients should confirm all CGM readings prior to making treatment decisions.

The risks of the device failing to alert an asymptomatic user to a high or low blood sugar is no greater than that associated with traditional blood glucose monitoring.

IX. SUMMARY OF PRECLINICAL STUDIES

A. Laboratory Studies

Pre-clinical testing was performed on the Animas Vibe System and on the Animas Vibe Insulin Pump. See the SSED for P120005 for additional pre-clinical testing performed on the Dexcom G4 Platinum CGM System.

Protocols, test reports and acceptance criteria have been reviewed and found to be acceptable.

The following functionality of the Animas Vibe Pump and System was tested:

- Case integrity testing,
- Dual vent functionality,
- Display functional testing,
- Keypad button functional testing,
- Vibrator motor functional testing,
- Audio piezo functional testing,
- Real time clock functional testing,
- Infrared interface functional testing,
- RF CGM interface functional testing,
- Pump rewind,
- Load cartridge,
- Prime and fill cannula functional testing,
- Occlusion detection functional testing,
- Loss of prime functional testing,
- Low insulin functional testing, and
- Delivery functional testing.

Design Verification Activities

Product and component verification testing was completed to demonstrate that the finished device performs in accordance with design specifications. An overview of these verification activities is provided below.

Pump and System Qualification

Insulin pumps were subjected to environmental and functional testing to ensure they continue to function normally even when exposed to extreme environmental conditions. Qualification testing of the pump and accessories, including cartridge, consisted of environmental stress conditioning including drop testing, pump cleaning, electrostatic discharge, mechanical vibration, storage temperature, humidity and atmospheric pressure and mechanical rigidity and strength. Environmental exposure testing confirms the pump remains functional after temperature, vibration and shock exposures are applied to the pump. Basal and Bolus delivery performance met the accuracy specifications at the minimum, intermediate, and maximum settings.

System level testing was conducted to verify that the system components worked together, and communication was maintained between components per specifications.

Pump and system level testing occurred over a range of environmental and test conditions. In many cases, devices were pre-stressed before undergoing additional functional testing.

Test	Purpose	Acceptance Criteria	Results
Pump Dimension, Weight, External Materials, Colors and Enclosure Finish	Verify pump design requirements.	Pump Dimension, Weight, External Materials, Colors and Enclosure Finish meet design requirements.	Pass
Real Time Clock (RTC)	Verify accuracy and non-volatility of pump's RTC.	RTC accuracy +/- 5 min over 28 days. RTC accuracy +/- 3 min over 12 hours after battery charge.	Pass
Pump RF Interface Testing	Verify pump firmware implements RF requirements.	Receive transmitter signal in range 2.4000-2.4835GHz. Min. 3 week battery life with Energizer L91 lithium battery.	Pass
RF Sensitivity	Verify pump receiver receives signals	Pump RF receiver receives signals at power level -70dBm or higher.	Pass
Operational Temperature, Humidity, Altitude	Verify pump meets functional requirements across operational specifications.	Functional tests at operational conditions: 5ºC and 20% RH 5ºC and 90% RH 40ºC and 20% RH 40ºC and 90% RH	Pass

		700 hPa 1060 hPa	
Mechanical Vibration	Verify pump meets mechanical vibration stress requirements.	IEC 60601-1-11, Broadband random vibration test.	Pass
Drop Testing	Verify pump meets functional requirements after drop test.	Pump is operational with no visible degradation to display after 1 meter drop.	Pass
ESD Compliance	Pump complies with immunity test levels for contact and air discharge.	IEC 60601-2-24 criteria for ESD used.	Pass
RFI Testing EMI/EMC Compliance	Pump complies with RFI, magnetic field requirements.	IEC 60601-2-24 criteria for RFI, magnetic field used.	Pass
Dielectric Withstand Compliance	Pump meets dielectric withstand compliance requirements.	IEC 60601-2-24 criteria for safety requirements after IPX7 and IPX8 testing.	Pass
Leakage Current Compliance	Verify pump is compliant with leakage current requirements.	IEC 60601-2-24 criteria for Leakage current test under type BF category and after pre-stress and IPX8 and IPX7 testing.	Pass
Over-Delivery Single Point Failure	Verify over-delivery under a single-point failure meets requirement.	An over-delivery under a single-point failure < 2 U.	Pass
Audio Alert Volume Testing	Verify audio alert volume.	IEC 60601-2-24 criteria for volume of auditory alarm signals.	Pass
Vibrator Motor Testing	Verify operation of pump vibration motor.	Minimum vibration 0.2 g.	Pass
Pressure Equalization and Vent Occlusion	Verify pump meets design requirements for pressure and vent occlusion.	Equilibrate pressure from 4.7 psig to 1.3 psig in <= 300 seconds.	Pass
Battery Type Requirement	Verify recommended battery type is specified in Owner's Booklet.	Energizer L91 Lithium battery recommended in Owner's Booklet.	Pass
Battery Shorting Testing	Verify pump external temperature does not exceed standard.	IEC 60601-1, clause 11	Pass
Basal Rate Accuracy	Verify pump meets basal rate accuracy requirements.	Basal rate accuracy +/- 5% across range of basal rates (0.025 U/Hr	Pass

		– 25 U/Hr) after pre-stress testing.	
Normal/Audio Bolus Delivery Rate Timing	Verify bolus delivery time.	250 msec – 1 sec for 1 U normal and audio bolus.	Pass
Extended Bolus Delivery Rate Timing	Verify extended bolus delivery time.	180 sec +/- 2 sec	Pass
Small Basal Volume Delivery	Verify small basal volume delivery	Volumes < minimum volume (0.0092 U) accumulate until min volume is reached.	Pass
Bolus Dose Accuracy	Verify pump meets bolus dose accuracy requirements.	+/- 5%	Pass
Rewind Maneuver	Verify pump rewind meets requirements.	Complete rewind in < 130 sec. Fully rewound to ½ filled cartridge position in < 55 sec.	Pass
Cartridge and Loss of Prime Detection	Verify pump load and prime meet requirements.	Detect absence of cartridge Terminate load cartridge when force > 0.6 lbf	Pass
Prime Maneuver – Delivery Time Testing	Verify pump delivery time meet requirements.	Prime 10 U in 3-6 sec.	Pass
Prime Maneuver – Max Volume	Verify pump prime meet requirements.	Prime volume 20 +/- 2 U or until button released.	Pass
Occlusion Threshold	Verify pump occlusion is detected.	Occlusion threshold <= 35 psi	Pass
Empty Cartridge	Verify pump detects empty cartridge condition.	Alarm occurs prior to cartridge empty.	Pass
Cleaning	Verify pump functionality and no deterioration to external surface.	Visual inspection and functionality testing.	Pass
IPX8 Testing	Verify pump functionality and no water ingress or degradation due to water testing.	IEC 60529 on pre-stressed pumps.	Pass
Mechanical Rigidity and Strength	Verify pump functionality, CGM communication, and	IEC 60601-1 Push Test	Pass

	display work properly.		
FCC	Verify pump adheres to FCC limits.	FCC CFR Title 47, part 15	Pass
OLED screen	Verify resolution of OLED screen	Per internal requirements.	Pass
Keypad Design	Verify pump keypad design meets requirements.	Requirements for material, graphics, and pushbutton type.	Pass
Pump Vent Testing	Verify pump vent requirements.	Vent from 8.50 to 0 psig in <= 30 sec.	Pass
Battery Housing Mechanical Construction	Verify battery reversal will not damage pump.	IEC 60601-2-24	Pass
Occlusion Sensitivity – Basal, Bolus	Verify occlusion detection time during basal and bolus delivery.	Occlusion detection time based on delivery rate.	Pass
RF Communication Testing	Verify firmware implements communication requirements.	Communication between pump and CGM is synced and functions as intended.	Pass
CGM Data Reception	Verify communication with single, recognized CGM transmitter.	Communication with pump is activated and maintained as intended without interference from other devices.	Pass
Bolus Delivery Timing – Not to Exceed	Verify timing of pump bolus delivery.	Bolus delivery time depends on delivery speed and bolus size.	Pass
Shipping and Handling Compliance	Verify compliance of storage, shipping, and handling conditions.	ISTA 2A	Pass
RF Frequency Measurements at Temperature	Verify RF packet reception with extreme frequency variability.	Pump receives RF packets from CGM within system operating temperature range of 10ºC-40ºC.	Pass
Storage Temperature, Humidity, and Altitude	Verify compliance with storage, shipping, and handling conditions.	Temp: -20ºC – 60ºC RH: 10%-100% Atm. Pressure: 500 hPa – 1060 hPa	Pass
Positive and Negative Height Differential	Verify fluid displacement when pump is located at positive and negative height differentials from infusion site.	Volume displacement not to exceed 0.01 mL in 2 hours when pump is 18 inches above infusion site. Volume displacement	Pass

		not to exceed -0.01 mL in 2 hours when pump is 18 inches above infusion site.	
Altitude Shock	Characterize pump performance at extreme atmospheric pressure conditions.	Characterization study.	Pass
ESD Stress Test	Verify functional performance after being subjected to high voltage levels of ESD.	No permanent degradation, loss of function or data loss.	Pass
Moulding Stress Relief Compliance	Pump complies with moulding stress relief requirement	IEC 60601-1	Pass
Impact Compliance	Pump complies with impact requirement.	IEC 60601-1	Pass
Loss of Prime Detection	Verify pump detects absence of cartridge and activates warning.	Detection of absence of cartridge and warning activated.	Pass
CGM Transmission Interference	Verify system recovers from EMI.	Communication re-established or error displayed within 45 minutes.	Pass
CGM Multiple User	Verify exclusivity of data communication.	Communication is exclusive between pump and recognized CGM. No data transmission from other CGMs.	Pass
CGM Range Test	Verify RF communication between CGM and pump.	RF communication when CGM and pump are within 12 feet, line of sight.	Pass
Battery Life Testing	Verify system meets requirements for battery life and battery alarms.	Minimum battery life: 3 weeks with recommended battery under normal use. Replace battery alarm at least 3 minutes prior to battery depletion.	Pass
History Data	Verify non-volatility of pump history data and CGM history data.	Pump history data and CGM history data will not be lost due to loss of power caused by removal of battery.	Pass

Component Qualification

Cartridge testing included assessment of mechanical and functional characteristics, in addition to the connection integrity with pump system and insulin compatibility and stability.

Electrical Safety and Electromagnetic Compatibility and Interference

A sequence of ESD/EMI/EMC and Product Safety testing for the System was performed by external accredited laboratories. The ESD/RF Immunity testing showed that the Vibe Pump and Dexcom CGM Transmitter (System) functioned correctly after exposure to electromagnetic fields. Emissions from the Pump and Transmitter were also tested for compliance and passed.

FCC regulatory testing for System Pump and Transmitter were conducted, according to requirements prescribed by the design specification as they relate to electromagnetic emissions and compliance with the applicable FCC standards. The testing for the System Pump and Transmitter were performed by external accredited laboratories and the Pump and Transmitter complies with the applicable standards.

RF wireless testing, including wireless co-existence, was conducted on the System. Testing indicated that the System can operate in the presence of RF interference and co-exist with other wireless devices operating in the same vicinity. The communication distance of 12 ft was verified when the Dexcom G4 CGM transmitter is worn on the body within the line of sight of the Pump. Testing was also performed to confirm that the Pump RF receiver circuit including the antenna is designed to receive signals from a Dexcom transmitter in the specified frequency range.

Insulin Compatibility and Stability

In vitro drug stability and compatibility testing performed on the pump and insulin cartridge indicates that Insulin is stable for 3 days. In-vitro stability was evaluated under worst case thermal (37°C + 2°C) and humidity (40% RH) conditions. The study observed acceptable results for assay, degradation products, impurities, leachables and extractables. All tested insulin products maintained insulin potency for the 6-day period, indicating minimal surface-induced denaturation.

Biocompatibility Testing

Biocompatibility testing has been performed on the exterior surfaces of the Animas Vibe Insulin Pump and Cartridge in accordance with the ISO 10993-1. All testing on the cartridge was conducted on sterilized product. For biocompatibility testing, the pump was classified as surface contacting device with > 30 day contact duration. The cartridge was classified as external communicating devices, tissue/bone/dentin, contact duration permanent (>30 days). The table below summarizes the biocompatibility testing conducted on devices representative of the final design.

Test	**Testing Conducted on**	**Result**

	Pump and/or Cartridge	
Cytotoxicity – ISO MEM Elution	Pump and Cartridge	Pass; Non-toxic
Sensitization – Guinea Pig Maximization	Pump and Cartridge	Pass; Non-sensitizing
Irritation / Intracutaneous Reactivity	Pump and Cartridge	Pass; Non-irritating
Acute Systemic Toxicity	Cartridge	Pass; No evidence of systemic toxicity
Materials Mediated Rabbit – Pyrogenicity	Cartridge	Pass; Non-pyrogenic
Subacute intraperitoneal toxicity testing	Cartridge	Pass; Non-toxic
Subacute intraperitoneal toxicity testing	Cartridge	Pass; Non-toxic
In Vitro Mouse Lymphoma Assay	Cartridge	Pass; Non-mutagenic
In Vivo Mouse Micronucleus Assay	Cartridge	Pass; Non-mutagenic
Bacterial Mutagenicity Test - Ames Assay	Cartridge	Pass; Non-mutagenic

Sterility/Shelf life

The Ethylene oxide (EtO) sterilization process used to sterilized the Animas 2.0 mL Insulin Cartridge was validated according to the requirements of ISO 11135-1 standard. Routine testing of biological indicators is performed to confirm that the sterilization process is effective in eradicating viable microorganisms. Results from sterilization studies demonstrate that the cartridge will maintain a Sterility Assurance Level (SAL) of 10^{-6}.

The shelf life of 2 years has been established through testing of cartridges and packaging exposed to real-time aging. Packing testing included visual inspection, packaging integrity testing, packaging challenge testing, dye penetration testing and pouch seal strength testing for the full shelf-life duration. The test results demonstrated that the packaging of the Animas 2.0 mL Insulin Cartridge meets the packaging requirements.

Expiration dating for the CGM sensor and transmitter components of this device has been established and approved for 6 months at storage conditions between 36ºF – 77ºF and between 15% - 85% relative humidity. A 7 day wear period has been established for the sensor component.

Packaging and Shipping Tests

Animas Vibe Insulin Pump Kits were packaged using standard materials and methods and subjected to shipping tests per the ISTA Procedure 2A guidelines. All pumps passed the inspection and functional testing after the shipping and handling tests.

Software Verification and Validation

Comprehensive verification and validation testing was conducted to confirm that the software used in the Animas Vibe Pump System meets all specified requirements and that the software will operate reliability and safely under normal or abnormal use conditions.

The software verification and validation were carried out in accordance with the FDA's "General Principles of Software Validation: Final Guidance for Industry and FDA Staff." Software development activities included establishing detailed software requirements, linking requirements with associated verification tests, software code reviews, unit testing, system level testing and defect tracking and dispositioning to ensure the software conforms to patient needs and intended uses.

Use and Labeling Verification Testing

User interface and human factors testing were performed. The testing considered device users, use environment, and user interfaces including device labeling and training. The summative study involved simulated use of the Animas Vibe System with 31 participants with differing levels of CGM experiences and diabetes therapy that were presented a series of realistic use scenarios for the Animas Vibe System and asked for their response. The Owner's Booklet was verified to provide the required information on how to operate the System safely.

B. Animal Studies

No animal studies were conducted using the Animas Vibe System.

C. Additional Studies

None.

X. SUMMARY OF PRIMARY CLINICAL STUDY

Dexcom performed a clinical study to establish a reasonable assurance of safety and effectiveness with the Dexcom G4 Platinum CGM System for detecting trends and tracking patterns when used as an adjunct to blood glucose testing in subjects with diabetes mellitus. Please see the original P120005 SSED for details on this clinical study, including Financial Disclosure information.

No additional clinical study was conducted using the Animas Vibe System.

XI. PANEL MEETING RECOMMENDATION AND FDA'S POST-PANEL ACTION

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

XII. CONCLUSIONS DRAWN FROM PRECLINICAL AND CLINICAL STUDIES

A. Effectiveness Conclusions

The results of the pivotal clinical study performed in P120005 establish a reasonable assurance of safety and effectiveness with the Dexcom G4 Platinum CGM System for detecting trends and tracking patterns when used as intended, as an adjuvant to blood glucose testing in subjects with diabetes mellitus. See P120005 SSED for additional information.

No additional clinical study was required for the Animas Vibe System. The pre-clinical test data presented above (Section IX) establish a reasonable assurance of safety and effectiveness for the Animas Vibe System.

The results of the pre-clinical testing demonstrate that the Animas Vibe System complies with the applicable voluntary standards for biocompatibility, sterilization, Electromagnetic Compatibility and Safety. The device passed all the testing in accordance with national and international standards. Internal verification and validation testing confirmed that product specifications were met which support the intended use and technological characteristics. The verification and validation of the device software were completed according to the FDA guidance entitled General Principles of Software Validation: Final Guidance for Industry and FDA Staff released January 11, 2002.

The clinical testing performed in P120005 for the Dexcom G4 Platinum CGM System and the non-clinical and human factors/usability testing completed on the Animas Vibe System and its components for this PMA support the operation of this device as a system.

B. Safety Conclusions

The risks of the device are based on nonclinical laboratory data of the Animas Vibe System (described above) as well as data collected in a clinical study conducted to support PMA approval of the Dexcom G4 Platinum CGM System as described in the SSED for P120005.

Potential device-related non-serious events related to CGM or insulin pump use include:

- Skin irritation or redness
- Infection
- Pain or discomfort
- Bruising
- Edema
- Rash
- Bleeding
- Allergic reaction to adhesives
- Hypoglycemia from over-delivery of insulin
- Hyperglycemia and ketosis possibly leading to ketoacidosis due to pump malfunction, or problems with the cannula, needle, or insulin infusion set tubing resulting in cessation of insulin delivery
- Loss of communication between the pump and the sensor resulting in CGM values not being available to the user
- Catheter occlusion
- Catheter dislodgement or fracture during infusion set insertion
- Failures of the infusion set or at infusion site
- Mechanical or battery failures resulting in interruptions in insulin delivery or incorrect insulin delivery

Sensor breakage with fragments retained under the skin and catheter fracture during infusion set insertion are potential procedure-related complication. Based on post-market experience with similar devices and the results observed in this clinical study, the occurrence and severity of these events do not raise major concerns.

One potential risk of combining the CGM and the pump is that the user might be more inclined to use the CGM data in an unapproved way to determine their insulin dose. Inaccurate sensor results, if used to make dosing decisions, may lead to hypo or hyperglycemia as the CGM sensor has not been approved to be used to dose insulin. However, no further complications are expected due to the pump being combined with the CGM as a system beyond the potential complications of the pump or CGM alone.

Like other insulin pumps, there is an inherit risk that patients who do not use the system as instructed (nonadherence) could harm themselves. Patients should be informed that sensor interstitial glucose values should not be used to make insulin dose decisions and that all threshold alerts and alarms should be confirmed with a blood glucose measurement.

A pump malfunction could lead to clinically significant hypoglycemic event, ketosis or ketoacidosis. A patient should respond with carbohydrate, insulin therapy, hydration, or other medical assistance as necessary. If unaddressed, severe hypoglycemia, severe hyperglycemia and ketoacidosis can result in serious harm and death.

The risks of actions taken based on false positive hyperglycemic readings include inappropriate or excessive administration of insulin and failure to treat hypoglycemia. These inappropriate treatments could result in or prolong hypoglycemia and result in seizures, loss of consciousness, or death. The risks of actions taken based on false positive hypoglycemic readings include failure to administer insulin and failure to treat hyperglycemia. False positive high alerts and low alerts and alarms may increase the number of unplanned blood glucose checks; and disrupt patient activity and sleep. If the false positive rate is too high it can result in 'alarm fatigue' and patients may deactivate these alerts/alarms.

The risks of actions taken based on false negative hyperglycemic readings include failure to administer or insufficient administration of insulin and inappropriate administration of extra carbohydrate. These inappropriate treatments could prolong or induce hyperglycemia. The risks of actions taken based on false negative hypoglycemic readings include inappropriate administration of insulin or failure to administer or insufficient administration of extra carbohydrate. These inappropriate treatments could result in or prolong hypoglycemia and result in seizures, loss of consciousness, or death. False negative high alerts and low alerts and alarms will prevent the patient from having the opportunity to perform unplanned blood glucose tests and treat as instructed by their healthcare providers.

The CGM component is to be used only for tracking and trending glucose levels. The risk related to either an inaccurate sensor value outside of the patient's normal range or a false alert or alarm is the risk of performing an unnecessary additional blood glucose test to confirm the erroneous sensor reading. The risk of medical harm may be mitigated through labeling which emphasizes that patients should confirm all CGM readings prior to making treatment decisions.

C. Benefit-Risk Conclusions

The probable benefits of the device are based on data collected in clinical and non-clinical studies conducted to support PMA approval as described above and in P120005.

Additional factors to be considered in determining probable risks and benefits for the Animas Vibe System included the following.

The CGM component of this system is intended to supplement self-monitoring of blood glucose to track and trend interstitial glucose levels as estimates of glucose excursions in the blood. The system provides continuous measurements of glucose in the tissue every 5 minutes for up to seven days for each sensor. Glucose trends and the hypoglycemia and hyperglycemia alerts are intended to warn patients that they need to test their blood sugar to see if they need to take action to treat or prevent a hypoglycemic or hyperglycemic event. Other benefits of the CGM component include the following:

- Provide information regarding patterns of glycemic excursions throughout the day and night when patients may be unable to test their blood glucose
- Aids in the detection of episodes of hyperglycemia and hypoglycemia (which may facilitate both acute and long-term therapy adjustments that may minimize episodes of hyper and hypoglycemia)

The insulin pump component of the system is indicated for continuous subcutaneous insulin infusion for the management of insulin-requiring diabetes. The pump is intended to assist patients in the management of their diabetes by allowing for various basal and bolus delivery settings. Other benefits of the pump component include the following:

- Ability to administer insulin frequently without repeated injection
- Ability to set different basal rates through the day to better match basal insulin requirements which may fluctuate during the course of the day
- Ability to calculate active insulin remaining from previous boluses to avoid "insulin stacking", which can lead to hypoglycemia
- Ability to administer bolus doses over an extended time
- Ability for patient to calculate appropriate bolus insulin doses based on their individual needs

The functions of the sensor augmented pump are not feasible using traditional blood glucose monitoring and insulin self-injections as blood glucose meters only provide information about discrete, intermittent blood glucose levels and therefore are unable to provide information regarding patterns of glycemic excursions throughout the day and night when patients may be unable to test their blood glucose.

Other benefits of the system include the following:

- Single user interface
- Convenience to user – one less device to carry

Risks of the CGM and sensor:

- Sensor error resulting in incorrect glucose readings
- Missed alerts and false negative hypoglycemic and hyperglycemic readings related to patients not being alerted to the need to perform a fingerstick to detect hypoglycemia or hyperglycemia
- False positive hypoglycemic and hyperglycemic readings or alerts leading to unnecessary fingersticks to evaluate their blood glucose.
- Skin irritation, or redness, inflammation, pain or discomfort, bruising, edema, rash, bleeding, infection, or allergic reaction due to either the sensor needle or the adhesive
- Sensor breakage leaving a sensor fragment under the skin

Risks of the pump include the following:

- Hypoglycemia from over-delivery of insulin due to a pump defect

- Hyperglycemia and ketosis possibly leading to ketoacidosis due to inappropriate pump failure or problems with the cannula, needle, or insulin infusion set tubing, resulting in cessation of or decreased insulin delivery
- Catheter dislodgement or fracture during infusion set insertion resulting in injury and/or inability to administer insulin
- Mechanical or battery failures resulting in interruptions in insulin delivery or incorrect insulin delivery
- Catheter occlusion resulting in missed insulin dosing
- Skin irritation, or redness, inflammation, pain or discomfort, bruising, edema, rash, bleeding, infection, or allergic reaction at the infusion site
- Failure of the infusion set or at the infusion site resulting in inability to administer insulin

Risks of the system include the following:
- Loss of communication between the pump and the sensor resulting in CGM values not being available to the user
- Use of inaccurate sensor values to make dosing decisions, resulting in an incorrect dose of insulin being delivered leading to hypo or hyperglycemia and their subsequent complications

These risks are similar to the risks associated with the separate components.

The previously approved CGM (P120005) has been integrated with the insulin pump so the information (results, alerts, alarms, etc.) for the pump and the CGM are displayed on the pump screen.

The benefits of the Animas Vibe System include the benefits of each of the pump and the CGM, and the additional benefits of a single user interface and the convenience to the user of not having to carry both a pump and the CGM receiver. There are no benefits lost through integration of the two devices into a single system. The risks of the Animas Vibe System include the risks of the pump and the CGM as well as the potential for loss of communication between the pump and the CGM and the use of inaccurate sensor values to make dosing decisions. These additional risks are similar to risks associated with the CGM, where communication between the sensor and receiver may be lost and users may use inaccurate sensor values to make dosing decisions. For risks associated with the System (including pump and CGM specific risks), risk mitigations include design, labeling, and patient training. The benefits of the CGM outweigh its risks and the benefits of the pump outweigh its risks. Similarly, for the Animas Vibe System, the benefits of the combined system outweigh the risks.

In conclusion, given the available information above, the data support that for continuous subcutaneous insulin infusion for the management of insulin-requiring diabetes and for detecting trends and tracking patterns in glucose levels, the probable benefits outweigh the probable risks.

D. Overall Conclusions

The data in this application support the reasonable assurance of safety and effectiveness of this device when used in accordance with the indications for use. The benefits of using the Animas Vibe System, as discussed above, outweigh the risks.

XIII. CDRH DECISION

CDRH issued an approval order on November 25, 2014. The final conditions of approval are cited in the approval order.

The applicant's manufacturing facilities have been inspected and found to be in compliance with the device Quality System (QS) regulation (21 CFR 820).

XIV. APPROVAL SPECIFICATIONS

Directions for use: See device labeling.

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

Post-approval Requirements and Restrictions: See approval order.