April 6, 2023

Siemens Medical Solutions U.S.A.
℅ Alexandra Fink
Sr. Manager, Regulatory Affairs
40 Liberty Blvd.
MALVERN PA 19355

Re: K222360
Trade/Device Name: AI-Rad Companion (Cardiovascular)
Regulation Number: 21 CFR 892.1750
Regulation Name: Computed Tomography X-Ray System
Regulatory Class: Class II
Product Code: JAK, QIH
Dated: February 17, 2023
Received: March 7, 2023

Dear Alexandra Fink:

We have reviewed your Section 510(k) premarket notification of intent to market the device referenced above and have determined the device is substantially equivalent (for the indications for use stated in the enclosure) to legally marketed predicate devices marketed in interstate commerce prior to May 28, 1976, the enactment date of the Medical Device Amendments, or to devices that have been reclassified in accordance with the provisions of the Federal Food, Drug, and Cosmetic Act (Act) that do not require approval of a premarket approval application (PMA). You may, therefore, market the device, subject to the general controls provisions of the Act. Although this letter refers to your product as a device, please be aware that some cleared products may instead be combination products. The 510(k) Premarket Notification Database located at https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfpmn/pmn.cfm identifies combination product submissions. The general controls provisions of the Act include requirements for annual registration, listing of devices, good manufacturing practice, labeling, and prohibitions against misbranding and adulteration. Please note: CDRH does not evaluate information related to contract liability warranties. We remind you, however, that device labeling must be truthful and not misleading.

If your device is classified (see above) into either class II (Special Controls) or class III (PMA), it may be subject to additional controls. Existing major regulations affecting your device can be found in the Code of Federal Regulations, Title 21, Parts 800 to 898. In addition, FDA may publish further announcements concerning your device in the Federal Register.

Please be advised that FDA's issuance of a substantial equivalence determination does not mean that FDA has made a determination that your device complies with other requirements of the Act or any Federal statutes and regulations administered by other Federal agencies. You must comply with all the Act's requirements, including, but not limited to: registration and listing (21 CFR Part 807); labeling (21 CFR Part 801); medical device reporting (reporting of medical device-related adverse events) (21 CFR 803) for devices or postmarketing safety reporting (21 CFR 4, Subpart B) for combination products (see

https://www.fda.gov/combination-products/guidance-regulatory-information/postmarketing-safety-reporting-combination-products); good manufacturing practice requirements as set forth in the quality systems (QS) regulation (21 CFR Part 820) for devices or current good manufacturing practices (21 CFR 4, Subpart A) for combination products; and, if applicable, the electronic product radiation control provisions (Sections 531-542 of the Act); 21 CFR 1000-1050.

Also, please note the regulation entitled, "Misbranding by reference to premarket notification" (21 CFR Part 807.97). For questions regarding the reporting of adverse events under the MDR regulation (21 CFR Part 803), please go to https://www.fda.gov/medical-devices/medical-device-safety/medical-device-reporting-mdr-how-report-medical-device-problems.

For comprehensive regulatory information about medical devices and radiation-emitting products, including information about labeling regulations, please see Device Advice (https://www.fda.gov/medical-devices/device-advice-comprehensive-regulatory-assistance) and CDRH Learn (https://www.fda.gov/training-and-continuing-education/cdrh-learn). Additionally, you may contact the Division of Industry and Consumer Education (DICE) to ask a question about a specific regulatory topic. See the DICE website (https://www.fda.gov/medical-devices/device-advice-comprehensive-regulatory-assistance/contact-us-division-industry-and-consumer-education-dice) for more information or contact DICE by email (DICE@fda.hhs.gov) or phone (1-800-638-2041 or 301-796-7100).

Sincerely,

Lu Jiang

Lu Jiang, Ph.D.
Assistant Director
Diagnostic X-Ray Systems Team
DHT8B: Division of Imaging Devices
and Electronic Products
OHT8: Office of Radiological Health
Office of Product Evaluation and Quality
Center for Devices and Radiological Health

Enclosure

SIEMENS Healthineers

DEPARTMENT OF HEALTH AND HUMAN SERVICES
Food and Drug Administration

Indications for Use

Form Approved: OMB No. 0910-0120
Expiration Date: 06/30/2023
See PRA Statement below.

510(k) Number *(if known)*

K222360

Device Name

AI-Rad Compaion (Cardiovascular)

Indications for Use *(Describe)*

AI-Rad Companion (Cardiovascular) is image processing software that provides quantitative and qualitative analysis from previously acquired Computed Tomography DICOM images to support radiologists and physicians from emergency medicine, specialty care, urgent care, and general practice in the evaluation and assessment of cardiovascular diseases.

It provides the following functionality:
- Segmentation and volume measurement of the heart
- Quantification of the total calcium volume in the coronary arteries
- Segmentation of the aorta
- Measurement of maximum diameters of the aorta at typical landmarks
- Threshold-based highlighting of enlarged diameters

The software has been validated for non-cardiac chest CT data with filtered backprojection reconstruction from Siemens Healthineers, GE Healthcare, Philips, and Toshiba/Canon. Additionally, the calcium detection feature has been validated on non-cardiac chest CT data with iterative reconstruction from Siemens Healthineers.

Only DICOM images of adult patients are considered to be valid input.

Type of Use *(Select one or both, as applicable)*

☒ Prescription Use (Part 21 CFR 801 Subpart D) ☐ Over-The-Counter Use (21 CFR 801 Subpart C)

CONTINUE ON A SEPARATE PAGE IF NEEDED.

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510(k) SUMMARY FOR AI-RAD COMPANION (Cardiovascular)

K222360

SW Version VA20

Submitted by:
Siemens Medical Solutions USA, Inc.
40 Liberty Boulevard
Malvern, PA 19355
Date Prepared: July, 26th 2022

This summary of 510(k) safety and effectiveness information is being submitted in accordance with the requirements of Safe Medical Devices Act of 1990 and 21 CFR §807.92.

1. Submitter

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3. Device Name and Classification

Product Name: AI-Rad Companion (Cardiovascular)
Trade Name: AI-Rad Companion (Cardiovascular)

Classification Name:	System, X-Ray, Tomography, Computed
Classification Panel:	Radiology
CFR Section:	21 CFR §892.1750
Secondary CFR Section:	21 CFR §892.2050
Device Class:	Class II
Product Code:	JAK
Secondary Product Code:	QIH

4. Predicate Device

Product Name:	AI-Rad Companion (Cardiovascular)
Propriety Trade Name:	AI-Rad Companion (Cardiovascular)
510(k) Number:	K183268
Clearance Date:	September 10, 2019
Classification Name:	System, X-Ray, Tomography, Computed
Classification Panel:	Radiology
CFR Section:	21 CFR §892.1750
Secondary CFR Section:	21 CFR §892.2050
Device Class:	Class II
Primary Product Code:	JAK
Secondary Product Code:	LLZ
Recall Information:	N/A

5. Indications for Use

AI-Rad Companion (Cardiovascular) is image processing software that provides quantitative and qualitative analysis from previously acquired Computed Tomography DICOM images to support radiologists and physicians from emergency medicine, specialty care, urgent care, and general practice in the evaluation and assessment of cardiovascular diseases.

It provides the following functionality:

- Segmentation and volume measurement of the heart
- Quantification of the total calcium volume in the coronary arteries
- Segmentation of the aorta
- Measurement of maximum diameters of the aorta at typical landmarks
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The software has been validated for non-cardiac chest CT data with filtered backprojection reconstruction from Siemens Healthineers, GE Healthcare, Philips, and Toshiba/Canon. Additionally, the calcium detection feature has been validated on non-cardiac chest CT data with iterative reconstruction from Siemens Healthineers.

Only DICOM images of adult patients are considered to be valid input.

6. Device Description

AI-Rad Companion (Cardiovascular) SW version VA20 is an enhancement to the previously cleared device AI-Rad Companion (Cardiovascular) K183268 that utilizes machine and deep learning algorithms to provide quantitative and qualitative analysis to computed tomography DICOM images to support qualified clinicians in the evaluation and assessment of cardiovascular diseases.

As an update to the previously cleared device, the following modifications have been made:

Segmentation of Aorta – Performance Improvement

Although the structure of the underlying neural network has not changed in the subject device of this submission, the performance was enhanced over the previously cleared device by adding training data (re-use of existing annotations + 267 additional annotations).

Aorta diameter measurements – Maximum Diameter Ascending, Descending Aorta

In the previously cleared device diameter measurements of the aorta were performed at nine predefined locations according to the AHA guidelines.

As an enhancement to the previously cleared device and subject of this submission are aorta diameter measurements at the locations of the maximum diameter of the ascending and the descending aorta.

Visualization of aorta's VRT and as cross-sectional MPRs – Maximum Diameter Ascending, Descending Aorta

In the previously cleared device visualization VRT and cross-sectional MPRs were provided at nine predefined locations according to the AHA guidelines.

As an enhancement to the previously cleared device, such visualization of the maximum diameter of the ascending and descending aorta were added to the subject of this submission.

Categorization of diameter measurements – Maximum Diameter Ascending, Descending Aorta

In the previously cleared device categorization of diameter measurements was performed at locations according to the AHA guidelines.

With the subject of this submission, the categorization of diameter measurements was extended to locations of the maximum diameter of the ascending and descending aorta.

Individual Confirmation of Aorta Findings

For the measurements of the aorta, only all the measurements could be accepted or declined in the predicate device.

Within the scope of this submission the concept of individual accept-, decline-possibility was introduced to all aorta measurements.

Structured DICOM Report (DICOM TID 1500)

In the predicate device, the system would produce results in form of quantitative, structured and textual reports and would generate DICOM Secondary Capture images which would be forwarded to PACS reading and reporting systems.

Within the scope of this submission, the system supports an alternative, digital output format for the same results. For this purpose, a DICOM Structured Report is generated which is both human and machine readable and, therefore, will support, e.g., a transfer of the results into the clinical report more efficiently. The DICOM Structured Report is compliant to the TID1500 format for applicable content.

Cloud and Edge Deployment

Another enhancement provided within this submission is the support of the existing cloud deployment in an on-premise deployment known as an edge deployment. The system remains hosted in the teamplay digital health platform and remains driven by the AI-Rad Companion Engine; however, with the edge deployment the processing of clinical data and the generation of results is performed within the customer environment. This system remains fully connected to the cloud for monitoring and maintenance of the system from a remote setup. At the time of this submission this feature has been cleared in submission K213706 (AI-Rad Companion Brain MR VA40) and is unchanged within this subject device.

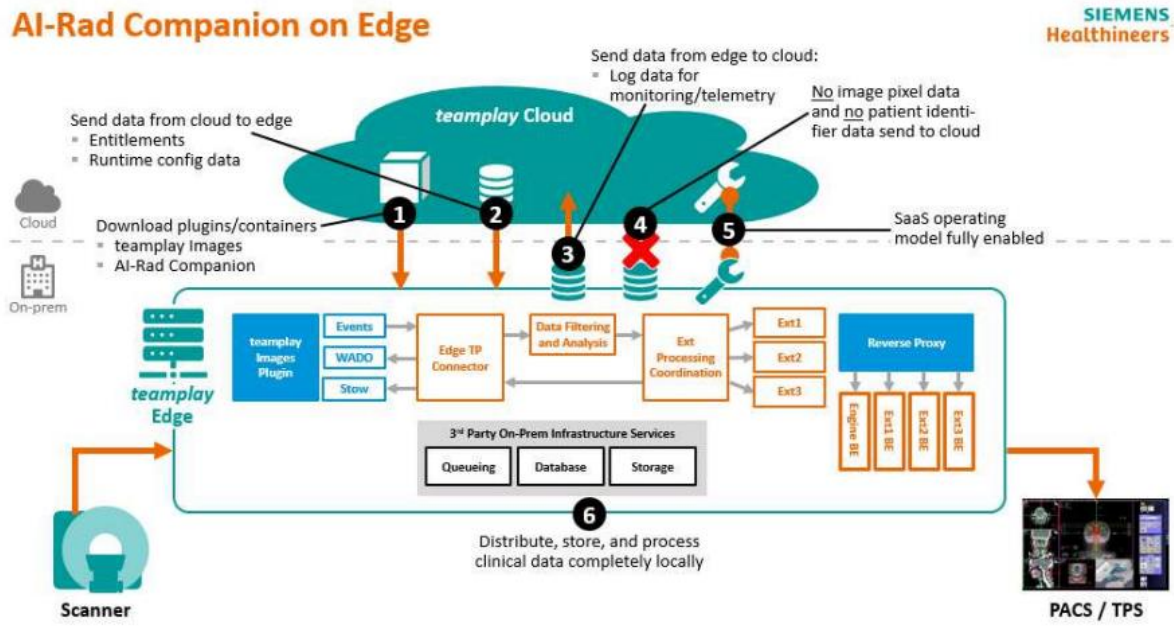

Figure 1 Illustration of the edge deployment for AI-Rad Companion

7. Technological Characteristics

The comparison between the above referenced predicate device is listed at a high-level in the following Table 1.

Table 1 Comparison of technological characteristics

Feature	Subject Device AI-Rad Companion (Cardiovascular) VA20	Predicate Device AI-Rad Companion (Cardiovascular) (K183268)	Result
Modality	CT	CT	Identical
Segmentation of heart	AI-based Heart Segmentation	AI-based Heart Segmentation	Identical
Detection of coronary calcium & quantification of coronary calcium volume	Calcium Detection with deep learning-based algorithm	Calcium Detection with deep learning-based algorithm	Identical
Visualization of heart and of calcium	Color overlay of MPR and VRT with evaluation results	Color overlay of MPR and VRT with evaluation results	Identical
Detection of aortic landmarks	Landmark Detection with deep learning-based algorithms, 9 AHA positions	Landmark Detection with deep learning-based algorithms, 9 AHA positions	Identical
Segmentation of aorta	Aorta Segmentation with deep learning-based algorithm with improved performance by adding training data (+ 267 additional annotations)	Aorta Segmentation with deep learning-based algorithm	Modified: improved performance of the algorithm
Aorta diameter measurements	Aorta diameter measurements at nine predefined locations according to the AHA guidelines and at the locations of the	Threshold-based classification of diameters into different categories	Modified: maximum diameter of ascending and descending aorta added

	maximum diameter of the ascending and descending aorta		
Visualization of aorta's VRT and as cross-sectional MPRs	Visualization VRT and cross-sectional MPRs at nine predefined locations according to the AHA guidelines and of the maximum diameter of ascending and descending aorta	Visualization VRT and cross-sectional MPRs at nine predefined locations according to the AHA guidelines	Modified: maximum diameter of ascending and descending aorta added
Categorization of diameter measurements	Categorization of diameter measurements at locations according to the AHA guidelines and at locations of the maximum diameter of ascending and descending aorta	Categorization of diameter measurements at locations according to the AHA guidelines	Modified: maximum diameter of ascending and descending aorta added
Reports	Results in form of quantitative, structured and textual reports, and DICOM Secondary Capture as well as DICOM Structured Report (TID 1500)	Results in form of quantitative, structured and textual reports, and DICOM Secondary Capture	Modified: format of DICOM report changed
Deployment	Cloud and Edge (on-premise) deployments	Cloud deployment	Modified: edge deployment added

8. Nonclinical Tests

Non-clinical tests were conducted to test the functionality of AI-Rad Companion (Cardiovascular). Software validation and bench testing have been conducted to assess the performance claims as well as the claim of substantial equivalence to the predicate device.

AI-Rad Companion has been tested to meet the requirements of conformity to multiple industry standards. Non-clinical performance testing demonstrates that AI-Rad Companion (Cardiovascular) complies with the FDA guidance document, "Guidance for the Content of Premarket Submissions for Software Contained in Medical Devices" (May 11, 2005) as well as with the following FDA recognized Consensus Standards listed in Table 2 below.

Table 2 Voluntary Conformance Standards

Recognition Number	Product Area	Title of Standard	Reference Number and Date	Standards Development Organization
5-114	General	Medical Devices – Application of usability engineering to medical devices [including Corrigendum 1 (2016)]	62366-1: 2015-02	IEC
5-125	General	Medical Devices – application of risk management to medical devices	14971:2019	ISO
13-79	Software/ Informatics	Medical device software – software life cycle processes [Including Amendment 1 (2016)]	62304: 2006/A1:2016	AAMI ANSI IEC
12-300	Radiology	Digital Imaging and Communications in Medicine (DICOM) Set	PS 3.1 – 3.20 (2016)	NEMA

Verification and Validation

Software documentation for a Moderate Level of Concern software, per FDA's Guidance Document "Guidance for the Content of Premarket Submissions for Software Contained in Medical Devices" issued on May 11, 2005, is also included as part of this submission. The performance data demonstrates continued conformance with special controls for medical devices containing software. Non-clinical tests (unit, integration and system) were conducted on the subject device during product development. In Summary all performance criteria have been fulfilled.

Siemens Healthineers adheres to the cybersecurity requirements as defined the FDA Guidance "Content of Premarket Submission for Management of Cybersecurity in Medical Devices: Guidance for Industry and Food and Drug Administration Staff" (October 2, 2014) by implementing a process of preventing unauthorized access, modifications, misuse or denial of use, or the unauthorized use of information that is stored, accessed, or transferred from a medical device to an external recipient.

9. Performance Software Validation

To validate the novel and updated features of the AI-Rad Companion (Cardiovascular) from the clinical perspective, the following algorithms underwent a scientific evaluation:

- Performance of aorta segmentation
- Aorta diameter measurements at the nine predefined landmarks and at location of maximum ascending and maximum descending aorta, respectively.

The results of clinical data-based software validation for the subject device AI-Rad Companion Cardiovascular demonstrated equivalent performance in comparison to the predicate device.

In more detail, the performance of the aorta segmentation module has been validated in a representative retrospective clinical cohort (N=315) and has shown substantially equivalent performance to the predicate device. For the subject device, average DICE (± std. dev) coefficient was 0.924 (± 0.046), v., 0.910 (± 0.066) for predicate device. Consistent performance has been observed for all relevant subgroups including device manufacturers, slice thickness, patient sex and age, and comorbidities.

The accuracy of the aortic diameter measurements was validated in a representative retrospective clinical cohort (N=193, including 50% of the cases with dilated aorta and 9% of the cases with aortic aneurysm). The test data has been chosen to be representative for the intended population consists of a cohort of consecutive patients undergoing Chest CT exams for varying indications in addition to a cohort at increased risk for incidental findings particularly in the cardiovascular domain, due to the screening nature of the examination. The evaluation included Bland Altman analysis, in particular detailed analysis of error and bias of individual subgroups.

With respect to the diameter measurements at the nine predefined locations, the predicate device yielded a bias within ±1.8 mm (95%-CI: [1.5 mm, 2.1 mm]) and mean absolute error (MAE) to be ≤2.4 mm (95%-CI: [2.1 mm, 2.6 mm]). For the subject device the bias was within ±1.5 mm (95%-CI: [0.9 mm, 2.0 mm]) and MAE ≤2.2 mm (95%-CI: [1.8 mm, 2.6 mm]).

Wirth respect to the diameter measurements at the location of maximum ascending and maximum descending aorta, respectively, inter-reader variability was assessed, and 95%-limits of agreement (LoAs) were established at ±3.51 mm. 91.9% of the measurements provided by the subject device were found to lie within the LoA, with a bias within ±1.5 mm (95%-CI: [1.2 mm, 1.8 mm]) and MAE ≤1.8 mm (95%-CI: [1.44 mm, 2.23 mm]).

For all diameter measurements consistent performance has been observed for all relevant subgroups including device manufacturers, slice thickness, patient sex and age, and comorbidities. In summary, all performance criteria have been fulfilled and the validation demonstrated substantially equivalent performance to the predicate device.

Summary Performance data

AI-Rad Companion (Cardiovascular) was tested and found to be safe and effective for intended users, uses and use environments through the design control verification and validation process and clinical data-based software validation. The Human Factor Usability Validation showed that Human factors are addressed in the system test according to the operator's manual and in clinical use tests with customer report and feedback form. Customer employees are adequately trained in the use of this equipment.

10. Clinical Tests

No clinical tests were conducted to test the performance and functionality of the modifications introduced within AI-Rad Companion (Cardiovascular). Verification and validation of the enhancements and improvements have been performed and these modifications have been validated for their intended use. The data from these activities were used to support the subject device and the substantial equivalence argument.

No animal testing has been performed on the subject device.

11. Safety and Effectiveness

The device labeling contains instructions for use and any necessary cautions and warnings to ensure safe and effective use of the device.

Risk management is ensured via ISO 14971:2019 compliance to identify and provide mitigation of potential hazards in a product risk analysis early in the design phase and continuously throughout the development of the product. These risks are controlled via measures realized during software development, testing and product labeling.

12. Substantial Equivalence and Conclusion

AI-Rad Companion (Cardiovascular) is substantially equivalent to the follow predicate device (Table 3).

Table 3 Predicate device for AI-Rad Companion (Cardiovascular)

Predicate Device	FDA Clearance Number	FDA Clearance Date	Main Product Code
AI-Rad Companion (Cardiovascular)	K183268	September 10, 2019	JAK

AI-Rad Companion (Cardiovascular) has the same intended use and technical characteristics compared to the predicate device, AI-Rad Companion (Cardiovascular) [K183268], with respect to the software features, functionalities and core algorithms. The enhancements and improvements provided in AI-Rad Companion (Cardiovascular) increase the clinical utility and reduce the complexity of the imaging workflow for the clinical user. The conclusions from all verification and validation data suggest that these enhancements are equivalent with respect to safety and effectiveness of the predicate device. These modifications do not change the intended use of the product. Siemens is of the opinion that AI-Rad Companion (Cardiovascular) is substantially equivalent to the currently marketed predicate device.