# *Executive summary*


3,2 meters = 3,2 billion km
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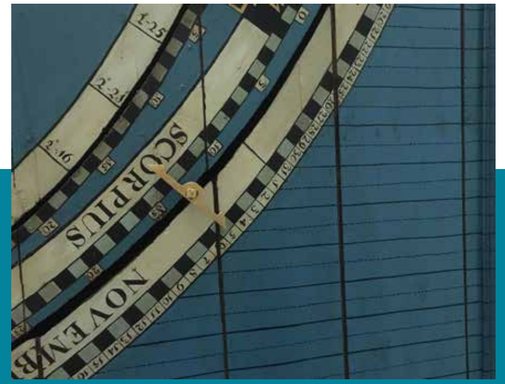
Around the sun the orbits of Mercury, Venus, Earth and Mars can be seen. The planets orbit the sun in 88, 224, 365 and 687 days respectively. Close to the earth there is another small sphere: the moon. Just like in reality, this moon rotates around the earth in 29.5 days. Outside the orbit of Mars, the planets Jupiter (11 years and 315 days) and Saturn (29 years and 164 days) orbit the sun. The largest moons of these planets are also shown. The other planets were only discovered after the Planetarium was built and are therefore missing. The spheres are half gilded and half painted black, indicating day and night sides. The distances of the planets are to scale, but the planet spheres are not: if they had been, the earth would have become invisibly small. In reality, the planetary orbits are not circles but ellipses, with the sun in one of the focal points. Consequently, the distance of a planet to the sun is not constant. This is approximated by eccentrically placing the circular orbits in the correct directions. The greatest distance is called the farthest point (VP) and the smallest distance the nearest point (NP). These points are also marked on the ceiling. Besides, the planetary orbits are not in the same plane as the earth's orbit around the sun – the so-called ecliptic plane. However, the inclination of the planetary orbits relative to the ecliptic is small: only a few degrees. The two points where the planets intersect the ecliptic plane are called 'nodes', with a distinction between the ascending (to the north) node and the descending (to the south) node. When a planet passes the ascending node, its distance to the ecliptic changes from negative to positive. The opposite happens when it passes the descending node. The numbers in the white circles around the planetary orbits indicate the position of the planet in relation to the nodes and how great the distance is. From this we can determine whether a planet is north or south of the ecliptic. In addition, the signs of the zodiac are painted along each planet's orbit, from which each planet's position in relation to the stars can be deduced.  Outside Saturn's orbit a seventh slot has been added, through which the date hand moves. On the outside, the hand indicates the correct date (day and month) while on the inside the position of the sun in the zodiac is indicated. Parallel lines run from the date circle to the side plinths on the ceiling, on which a scale division has been applied. These lines indicate the declination of the sun throughout the year. The declination is the height of the sun in the sky, measured in relation to the celestial equator. Around 21 June, the sun reaches its highest point in the sky, while around 21 December it is at its lowest. Around 21 March and 21 September, the sun is exactly on the celestial equator. The date hand traverses the slot in one year. In the case of a leap year, the hand must be moved back one day. Eisinga made a special provision for this. The date wheel is disconnected from the central drive and set back one day. So it is 28 February twice.




A seventh slot has been added outside Saturn's orbit, through which the date hand moves. On the outside, the hand indicates the correct date (day and month), while on the inside the position of the sun in the zodiac is indicated. This photograph shows the situation on 5 November, when the sun is at 14 degrees in the sign of Scorpius (Scorpio) and has a declination of almost -17 degrees.

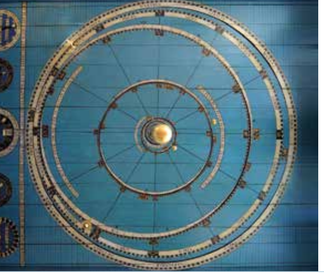
# The solar system in the living room

***In order to accommodate the solar system*** in his living room, Eise Eisinga had to shrink reality by a factor of 1 trillion (thousand billion). This means that one millimetre on the ceiling in reality equals one million kilometres! On the ceiling he depicted the solar system with the sun in the centre and the planets that were known at the time around it. In addition to the solar system, all kinds of hands were installed on which the current data about our solar system can be read on a daily basis. In the centre, the sun is represented by a star. Around the sun several slots have been cut out, through which the planets move. The planets are suspended like spheres from metal rods that protrude through the slots in the ceiling.

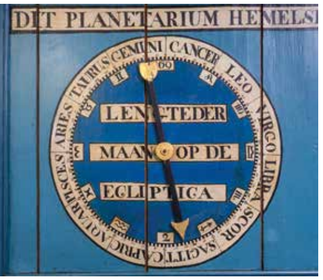



# The cog mechanism dissected

***All the planets, hands and clocks*** of the Eisinga Planetarium are driven by an elaborate system of oak hoops and discs, fitted with thousands of hand-forged nails. This cog mechanism is powered by a pendulum clock with one weight. This clock only ensures the correct speed: the driving force is provided by eight weights connected to the main axes of the cog mechanism. The pendulum of the clock swings eighty times per minute. During the year, the pendulum length has to be slightly adjusted, due to temperature changes. Absolutely everything is powered by this clock: for example, the planets up to and including the hand indicating the ever-changing times of moonrise and moonset. To achieve this, Eisinga made use of eccentric wheels, on which nails (acting as 'teeth') are placed in such a way as to make the wheel rotate at varying speeds. Such an eccentric wheel engages with the pins of a so-called lantern pinion (two parallel discs connected with long pins), so that the engagement will continue to exist. The hoops that set the planets and also the date hand in motion are supported and held in place by wooden rollers. A hoop of this kind is located above every slot in the underlying ceiling.



**01** • The planets in the Planetarium move clockwise, which means that we are looking at the solar system from the south side.




**02** • The moon moves within a fixed path across the sky, just like the sun and the planets. This path also contains the constellations of the zodiac. These constellations can be seen as a band in the sky where we can always find the sun, the moon and the planets. This clock indicates which constellation the moon is in.


**03** • The complex interplay of the movements of the earth, the moon and the sun causes the farthest point of the lunar orbit to shift over a period of 8 years and 311 days.


**04** • Above the closet-bed there are five dials on the ceiling. The middle one indicates the correct day of the week. The correct (local) time can also be read. The days of the week are named after the seven celestial bodies that were known at the time: Sunday (the sun), Monday (the moon), Tuesday (Mardi – Mars), Wednesday (Mercredi – Mercury), Thursday (Jeudi – Jupiter), Friday (Vendredi – Venus) and Saturday (Saturn). The names of the days also correspond to the names of Germanic gods such as Wodan, Donar and Freyja. This dial also has a rectangular opening in which the correct year can be read. On 31 December, around four o'clock in the afternoon, the year indicated starts to shift and at midnight the new year appears. The board on which the years are painted must get a new series of years every 22 years.


**05** • The complex interplay of the movements of the earth, the moon and the sun cause the lunar nodes in the sky to shift. They pass through the zodiac in a period of 18 years and 228 days.


**06** • The moon is lit by the sun. Because the moon rotates around the earth, we will always see a different part of the moon being lit. This is how the lunar phases arise.


**07** • Like the sun, the moon rises in the east and sets in the west. The times this takes place differ strongly. On average, the hands that indicate this are moving 48 minutes per 24 hours. The smallest time difference is 11 minutes, but it can also be an hour and a half! In order to reproduce this, Eisinga used eccentric cogwheels.


**08** • The two small clocks next to the closet-bed provide information about the lunar orbit. Because the lunar orbit around the earth is elliptical, the distance from the moon to the earth is not always the same. The point where the distance is greatest is called the farthest point (VP). This point is reached when the hands of the clock indicating 'distance of the moon from the farthest point' are both at zero. That is when the distance between the earth and the moon is at its greatest. If the large hand is at zero and the small one at six, the moon is at the nearest point (NP). The moon is then nearest to the earth.


**09** • Above the closet-bed is the 'square of heaven or planisphere'. Because the earth rotates on its axis in 24 hours, the sun and the stars appear to move from east to west. This disc shows the movement of the sun and the rotation of the starry sky, as seen from Franeker. The clocks next to the disc indicate the times of sunrise and sunset. As the earth rotates, it also moves around the sun. This makes the sun appear to move across the sky in a year. The disc is slotted to carry a sun figure moving through the zodiac, completing one cycle a year. The sun figure indicates the time of day on the 24 hours scale surrounding the planisphere.

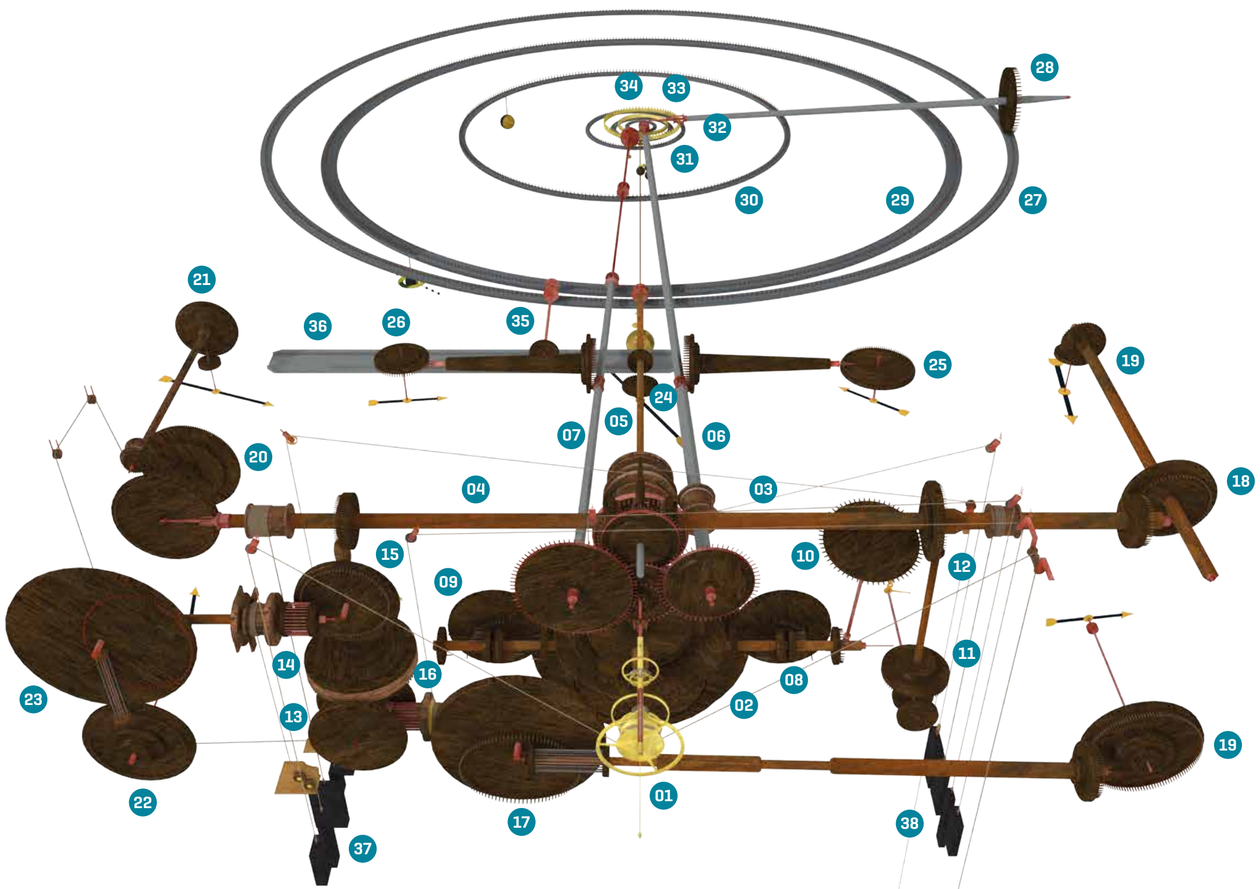

**10** • The lunar orbit is somewhat at an angle in relation to the earth's orbit around the sun. As a result, one half of the lunar orbit is north of the earth's orbital plane and the other half south. Consequently, the moon intersects the earth's orbit twice during the lunar orbit around the earth. These points of intersection are called 'nodes'. One is called the ascending or north node, the other the descending or south node. When the moon is in one of the nodes, a solar or lunar eclipse can occur. If the hands of both clocks are at zero, and the hand of the moon phase is on new moon, there will be a solar eclipse somewhere in the world. In the case of full moon, there will be a lunar eclipse. Due to the complex interplay of the movements of the earth, the moon and the sun, the moon's nodes in the sky will shift. They pass through the zodiac in a period of 18 years and 228 days.


**11** • This hand indicates the time the moon sets in the west.

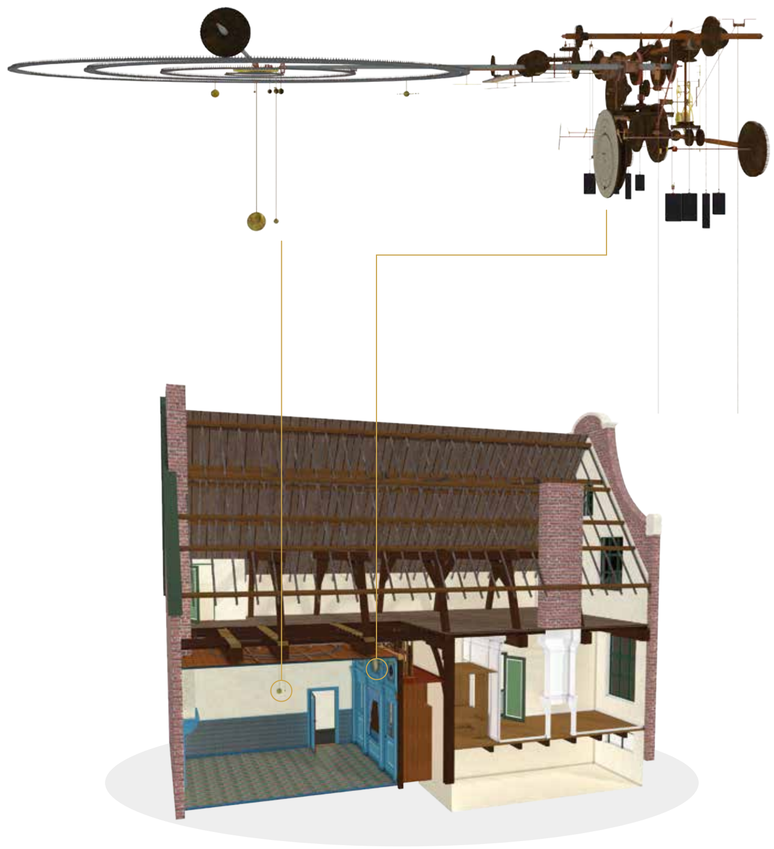
***Listed below is an overview of the various components of the cog mechanism.***
***The numbers refer to the illustration on the right.***

01 Pendulum clock
02 Square of heaven (four discs)
03 Farthest Point moon axis 1
04 Farthest Point moon axis 2
05 Drive date wheel and day hand
06 Drive planets Mercury and Venus and position Farthest Point moon (VP)
07 Drive planets Mars, Jupiter and Saturn and position Ascending Node moon (KK)
08 Sunrise
09 Sunset
10 Drive 'Sunrise' and 'Sunset'
11 Distance moon to farthest point
12 Drive moon to farthest point
13 Distance moon to north node
14 Transmission node wheels
15 Upper node moon wheel
16 Lower node moon wheel
17 Eccentric cog wheel, drive 'Moonrise'
18 Moonrise
19 Drive position moon in ecliptic
20 Eccentric transmission moon phases
21 Hand moon phases
22 Drive 'Moonset'
23 Transmission 'Moonset'
24 Drive day hand
25 Drive moon in VP
26 Drive moon in KK
27 Date wheel
28 Transmission drive Earth
29 Wheel Saturn
30 Wheel Jupiter
31 Wheel Mars
32 Wheel Earth and moon
33 Wheel Venus
34 Wheel Mercury
35 Drive yearboard
36 Yearboard
37 Five weights (for timepiece, date wheel, VP axis, node wheel, moon phases)
38 Four weights (axis drive of the planets Mercury, Venus, Mars, Jupiter and Saturn, and of lower node wheel and VP axis)

TOP VIEW




SIDE VIEW





**STATE PARTY**
Kingdom of the Netherlands

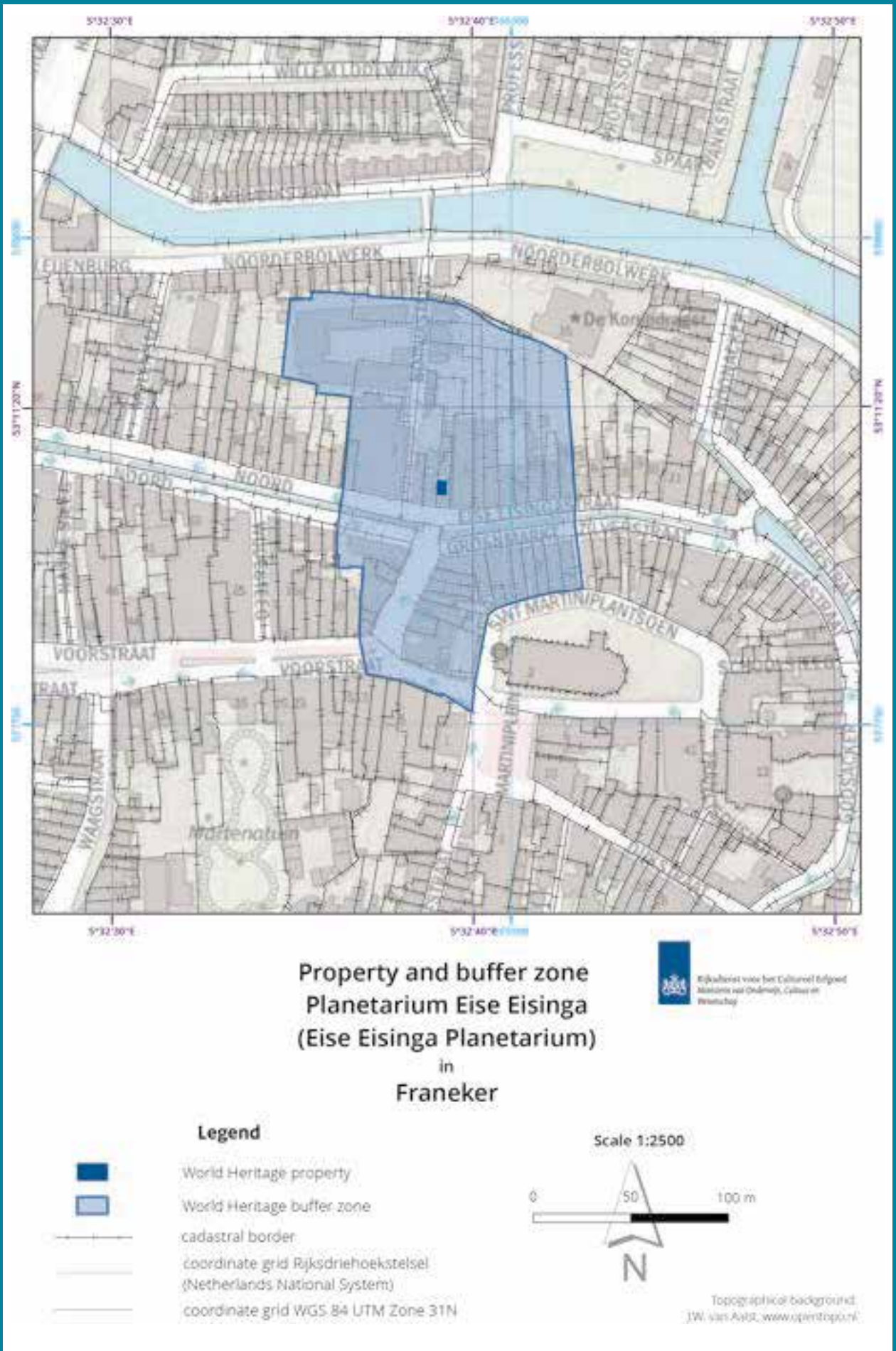
**STATE, PROVINCE OR REGION**
Municipality of Waadhoeke, Province of Fryslân (Friesland)

**NAME OF THE PROPERTY**
Koninklijk Eise Eisinga Planetarium (Royal Eise Eisinga Planetarium)

**GEOGRAPHICAL COORDINATES**
N 53°11'14.55"; E 5°32'37.51"

**TEXTUAL DESCRIPTION OF THE BOUNDARIES OF THE NOMINATED PROPERTY**
The boundary of the nominated property has been drawn in order to encompass all the attributes that are a direct and tangible expression of its Outstanding Universal Value.

The property measures 0.0027 hectare and encompasses the planetarium (i.e. orrery) in the former living room of the canal house Eise Eisingastraat 3 in the town of Franeker. It is fully owned by the municipality of Waadhoeke in the province of Fryslân (Friesland), in the northern part of the Netherlands. The buffer zone encompasses the immediate vicinity of the property and covers an area of 2.12539 hectares.




7. Nominated property with buffer zone. Cultural Heritage Agency of the Netherlands.

See maps enclosed in file.

**CRITERIA UNDER WHICH INSCRIPTION IS PROPOSED**
(i), (iii), (iv)

**DRAFT STATEMENT OF OUTSTANDING UNIVERSAL VALUE**

***a. Brief synthesis***
The Royal Eise Eisinga Planetarium is the oldest continuously operating planetarium (i.e. orrery) in the world. It is located in the historic centre of Franeker, one of the eleven historical cities in the province of Fryslân (Friesland), in the north of the Netherlands.

This accurately working model of our solar system was built between 1774 and 1781 by an ordinary citizen: the Frisian wool manufacturer Eise Eisinga. The mechanism consists of simple but robust components, such as wooden hoops and discs, and iron pins. It provides an up-to-date and realistic image of the positions of the sun, the moon, the earth and the five other planets that were known at the time.

The mechanism, ingeniously powered by one single pendulum clock, is built into the ceiling and at the top of the bed box of a living room. From the time that the planetarium instrument was completed, the room itself has continuously served as a reception and presentation area. To this day, it is open to the general public and used as an astronomical education centre.

The Eisinga Planetarium stems from a private initiative that was originally aimed at knowledgeable amateur astronomers, but soon took on a broader public function. It is characteristic of its time, in which science was increasingly being imbedded in society.

The combination of a permanent presentation, a great diversity of functions and the presence of a reception area is totally unique for a planetarium of that time. It makes the Eise Eisinga Planetarium an early predecessor of the many modern ceiling and projection planetariums. The excellently maintained instrument still functions as it did in 1781, and visitors are still given an explanation there about the functioning of our solar system – just as its maker intended.

***b. Justification for criteria under which inscription is proposed***

**Criterion (i): Represents a masterpiece of human creative genius**

The Royal Eise Eisinga Planetarium is an iconic example of an 18th-century orrery, representing exceptional creativity in both its extraordinary technical design and execution, and artistic expression. It is the world's oldest functioning planetarium where visitors can walk in to be informed about what is happening in the skies.

The Eisinga Planetarium is ingeniously built into the ceiling and the closet-bed wall of the living room of a former civilian home. That way it was possible to build a large orrery and use the underlying room as a reception and presentation area – just as in modern planetariums.

The orrery, which is in operation almost continuously since 1781, was designed and built by an ordinary citizen, with the use of ordinary materials. This opened the way for unprecedented design solutions that resulted in a very sophisticated instrument. It allows the beholder to see the current positions of the planets and the moon at one glance.

The fact that the Planetarium is still in working order, is largely due to the creative genius and foresight of its maker, the Frisian wool manufacturer Eise Eisinga, who left detailed instructions for the maintenance of his instrument.



**Criterion (iii): Bears a unique testimony to a living cultural tradition**
The Royal Eise Eisinga Planetarium bears a unique testimony to the cultural tradition of presenting and providing insight into celestial phenomena, using technology. This is a universal tradition, going back thousands of years, that lives on to this day.

It still functions exactly as it did when it came into operation in 1781 and, according to the consecutive series of guest books, all this time retained its inspiring educational function – receiving and educating visitors in a space where they can see the solar system and the starry sky portrayed above their heads.

Since its completion in 1781, the mechanism has been maintained according to its maker's instructions. Thanks in part to these extensive maintenance instructions, the Eisinga Planetarium continues to present the accurate positions of the sun, the moon and the planets of our solar system.

**Criterion (iv): An outstanding example of a technological ensemble which illustrates a significant stage in human history**

The Royal Eise Eisinga Planetarium illustrates a significant turning point in human history: the democratisation of science, which has permanently changed society. It is typical of the importance attached to the transfer of knowledge to a wider audience in 18th-century society. The intertwining of the instrument with the ceiling and the closet-bed of an existing living room symbolises, as it were, the increasing linkage of science and society.

The Planetarium was built by an ordinary citizen and was from the outset intended and used for educational purposes. Educated citizens could read the current celestial positions of the planets at a glance, and interested laymen were given insight into the 'functioning' of the solar system, based on the explanation provided at the instrument. This makes the Planetarium an object that bridges the gap between people of different educational levels and social classes.

As a technological ensemble, it continues to contribute to the dissemination of astronomical knowledge, and in particular the heliocentric worldview, in society.

***c. Statement of Integrity***
All the tangible elements and attributes required to express the Outstanding Universal Value of the candidate for nomination sit within its boundaries. The property is owned solely by the municipality of Waadhoeke, in the north of the Netherlands, and consists of six tangible attributes. Since the Royal Eise Eisinga Planetarium is still in full use, it is subject to wear and tear. But thanks to a very strict maintenance regime, almost all of the original parts have been preserved. The integrity of the property is therefore 100%.
The whole is inextricably linked to the building Eise Eisingastraat 3.

***d. Statement of Authenticity***
Although the Eise Eisinga Planetarium has been in operation just about continuously since 1781, the instrument has retained a high level of authenticity. Aside from necessary repairs, the various components of the planetarium instrument have remained unchanged since its completion. And the character of the room it is part of has been preserved. The authenticity of the Planetarium is confirmed, for example, by the first complete description of it, published in 1780 by Franeker University professor Jean Henri van Swinden, and by the description with maintenance instructions drawn up by Eise Eisinga in 1784. Its authenticity is also reflected in the almost complete series of guest books that have been kept from the very beginning. It proves that ever since the inauguration in 1781, the workings of our solar system have continuously been explained in the room below the Planetarium.

***e. Requirements for protection and management***

The former residence of Eise Eisinga, including the planetarium instrument, has been designated as a national monument by the State. A permit is required for changes to national monuments, in which respect it is carefully considered whether the plans are in accordance with the monumental values of the building.

In addition, the Planetarium building is entitled to bear the blue and white shield – the international distinguishing mark to indicate cultural heritage sites protected by the 1954 Hague Convention (a convention under the auspices of the UN and UNESCO for the Protection of Cultural Property in the Event of Armed Conflict).

Another important legal protection regime applies to the status of protected cityscape of the inner city of Franeker (now part of the municipality of Waadhoeke) since 1979. The protection is not aimed directly at individual buildings, but mainly at the historical characteristics, the urban planning structure and the layout of the public space. This protection of the area has been given a key position in the zoning plan for the inner city of Franeker. The entire buffer zone falls within the boundaries of one zoning plan, namely the 'Franeker – Inner City' zoning plan dating from 2016.

The municipality of Waadhoeke has a structural subsidy relationship with the Planetarium. On the basis of this relationship, an annual implementation agreement is drawn up in which the tasks of the Planetarium are stipulated. Since 15 June 2021, the Planetarium is also included in the subsidy structure of the province of Fryslân.

The municipality has committed itself to the sustainable maintenance and the conservation of the Planetarium. For the supervision of these management tasks, the Royal Eise Eisinga Planetarium Foundation was established in 2001. The board of this foundation consists of five representatives from scientific fields, the financial world and the local community. The day-to-day business is carried out by a managing director and nine employees.

Since it came into operation in 1781, maintenance of the planetarium instrument has taken place on the basis of the instructions of its maker, and is carried out by experienced staff and skilled external restorers.



# *Name and contact information of official local institution*

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*Adrie Warmenhoven, Managing Director*

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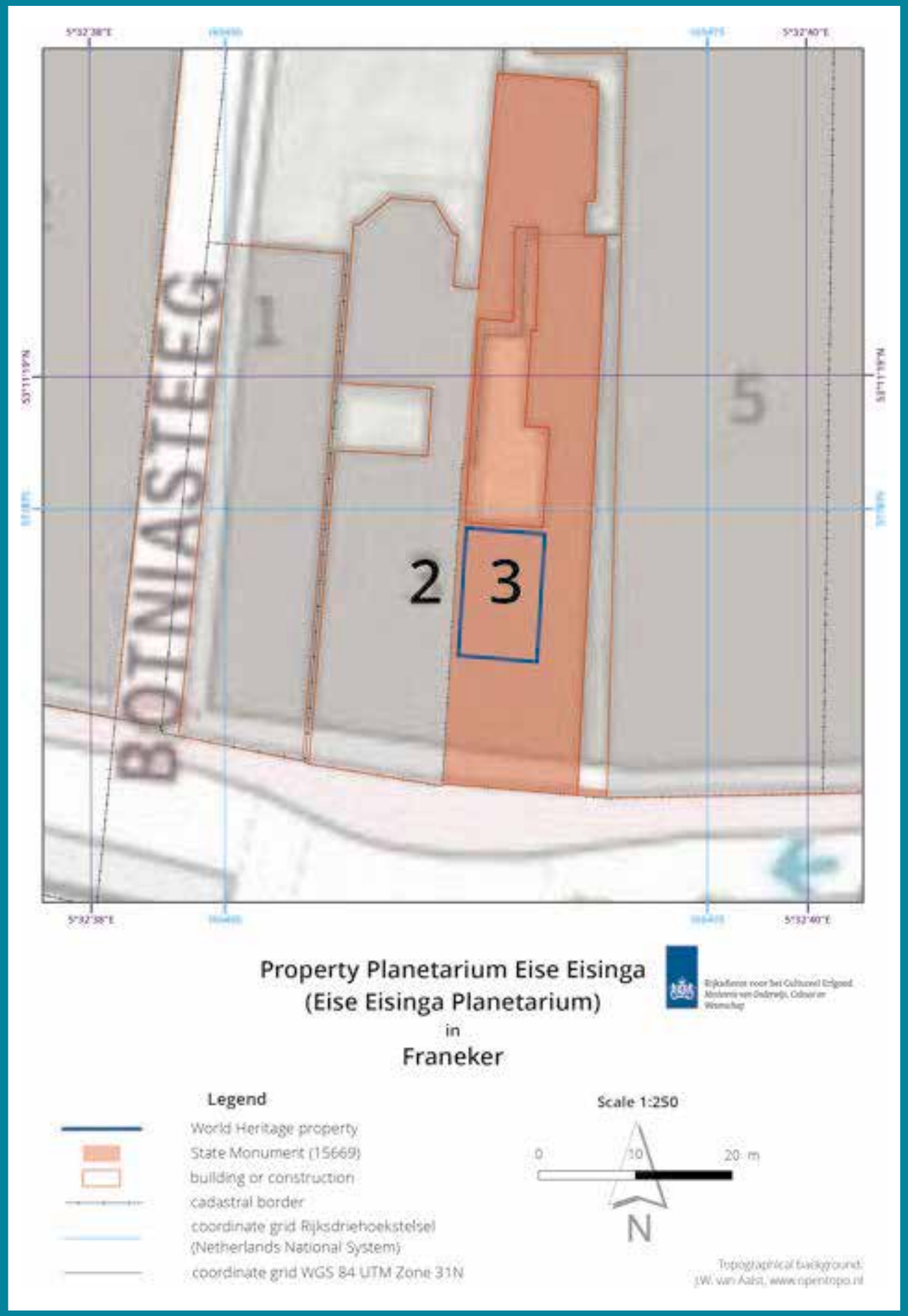
**Email:** a.warmenhoven@planetarium-friesland.nl
**Web address:** www.planetarium-friesland.nl

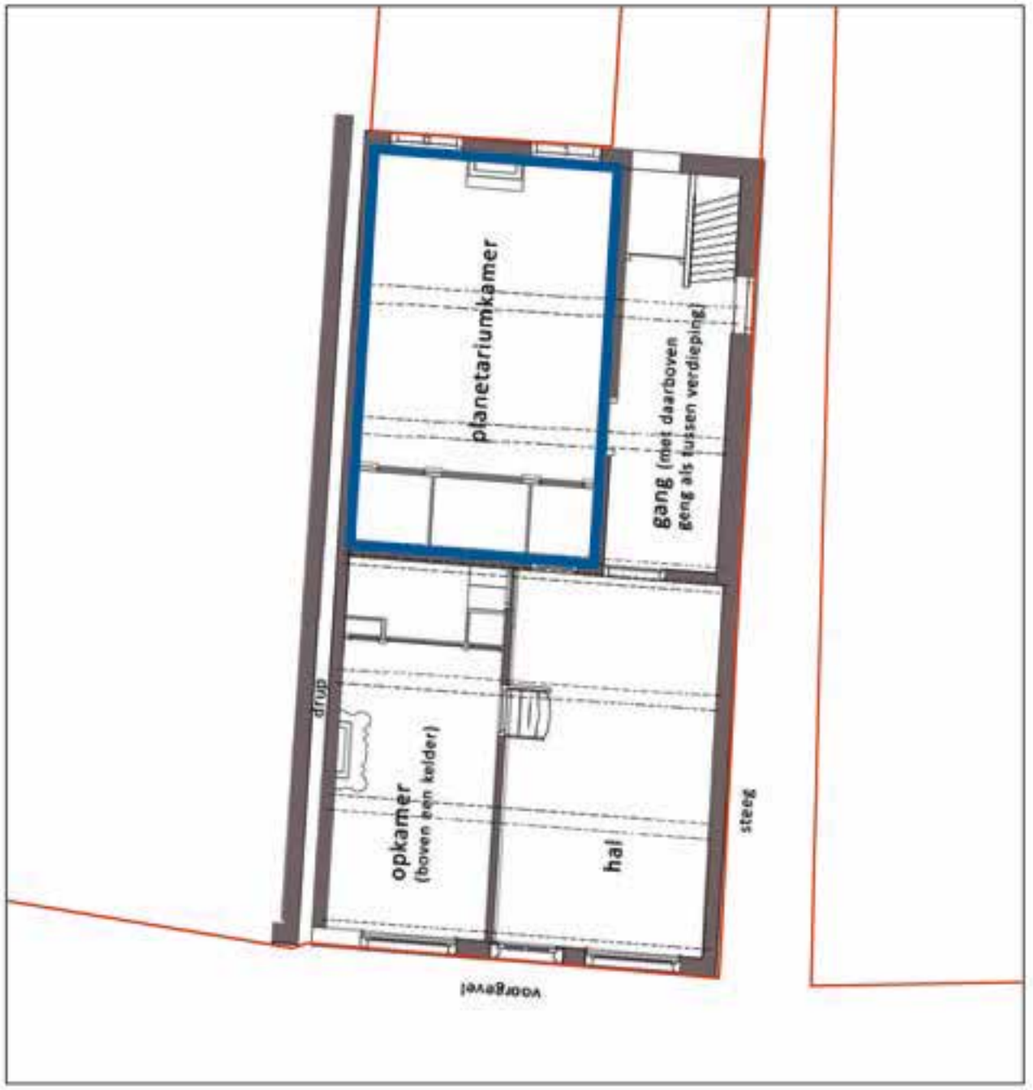
**Gemeente Waadhoeke (Municipality of Waadhoeke)**
*Mayor and Aldermen*

P.O. Box 58
8800 AB  Franeker

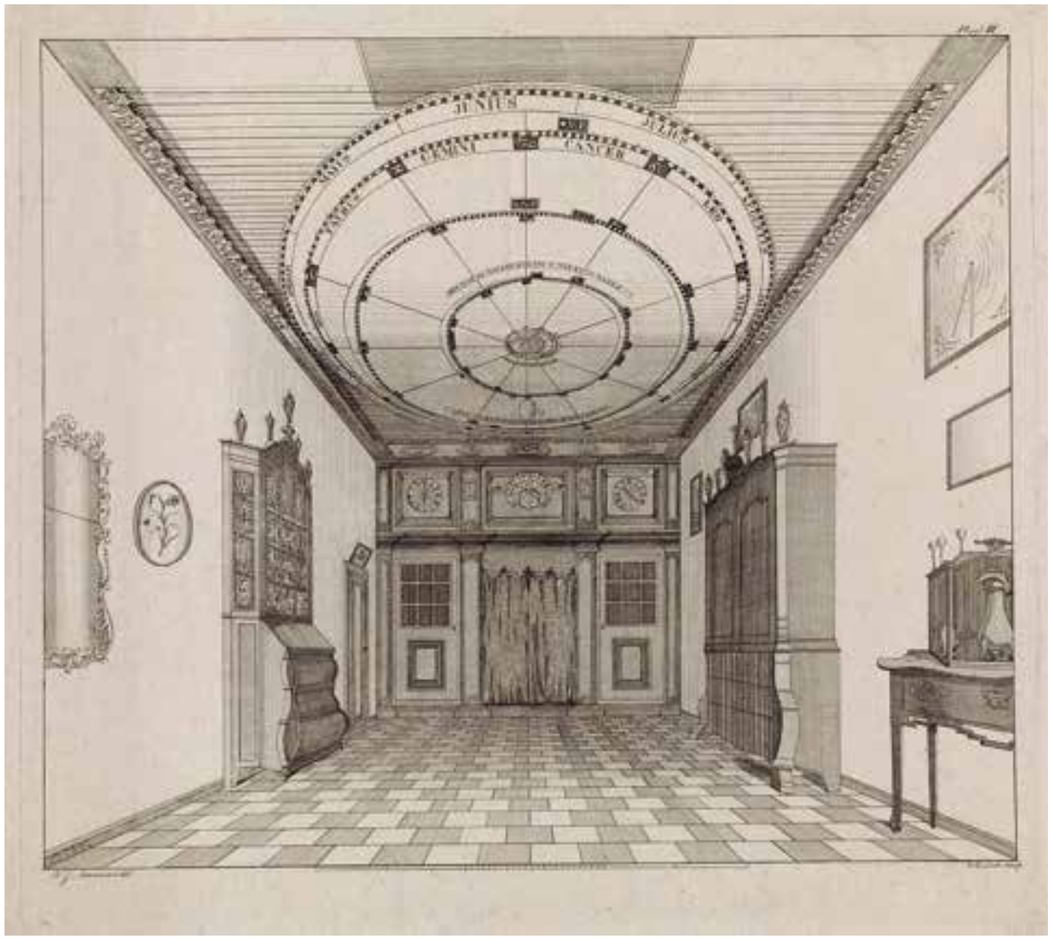
**E-mail:** m.visser@waadhoeke.nl
**Web address:** www.waadhoeke.nl




8. Map of the area of the nominated property.




9. Map of the nominated property. Cultural Heritage Agency of the Netherlands.




10. Planetarium room, engraving by Barentie Willem Dietz, after Claas Johannes Sannes, 1824.