FVA industry sub-group on technical requirements

01.09.2022

Summary for goals & next steps (1/2)

Focus on high level requirements regarding forward [and side] field of vision of the driver, for FVA systems only
(no low level detail to allow different systems in the future that are not yet scope of discussion and may have different technology than today's systems)

1. Define which ~~requirements apply to~~ **performances required from** HUD and FVA systems and which only apply to FVA systems
2. Define the cases when the requirements must be considered (e.g. optional display vs. displaying mandatory information)
3. Define positive requirements for HUD and FVA systems such as:
   a. minimum brightness if switched on
   b. Readability
   c. optical quality requirements
   d. Eyebox size
   e. minimum virtual image distance for FVA systems – also consider that holographic or 3D displays may have low physical VI distance but Image can be seen further away by the human eye

→ refers to UNECE R121: matter of changes?

4. Define negative requirements for HUD and FVA systems such as:
   a. maximum brightness at night (and how to measure, e.g. against forward brightness)
   b. HMI requirements regarding coverage
   c. [visibility from outside - example: an OLED display in windscreen could be seen by and distract other road participants, therefore not allowed)]

Summary for goals & next steps (2/2)

5. Generate logic structure/clusters as basis for future discussions
   a. Define common and different requirements for:
      - dynamic driving task in responsibility of driver
      - dynamic driving task in responisbility of car

   b. Address the difference between „optional“ systems and such that are the only place to display mandatory information
      - clarify if FVA has to be considered at all for mandatory information or if such information would only reside in the area of classic HUD displays (static symbol area)
      - Consider, that typically both (FVA contents and static contents) are being provided by the same HUD system; do we then need to distiguish between requirements for mandatory symbols in static symbol area and FVA?

6. additional points to be discussed

7. ~~link~~**reference** to R10 for electromagnetic compatibility (EMC) ~~and~~**or other regulations** **e.g.** R151 (slide 4) for side ~~vision~~**M2M3N2N3 vehicle detection and alert of a cyclist.**

1. Requirements that apply to FVA systems

- Requirements for FVA systems
  - HMI design rules regarding coverage
  - switch to safe state in case of electrically detectable failures
  - test scenarios for malfunction detection
  - No blinding (brightness adjustment according to outside brightness)
  - Maximum brightness value at given outside brightness

→ refers to UNECE R121: matter of changes?

  - Maximum latency requirement for augmented content (= threshold latency value to being distractive, not „good design“ latency value!)
  - Visibility of content in case of displaying mandatory information
    - Polarized sunglasses (reduced brightness or almost not visible at all)
    - Eyebox requirement <u>for the mandatory content</u> (e.g. minimum size: containing the eye points for 5 percentile woman and 95 percentile man, considering worst case tolerances (mounting tolerance , influence of windscreen, system tolerance)
      - ➢ Is adjustment by driver allowed to maintain above requirement? Discuss analogy to current display location of mandatory symbols in instrument cluster vs. steering wheel and seat adjustment
  - Ability to be switched off (not applicable if mandatory information is being displayed; this has to be explicitely mentioned in UNECE R125 as addition to „switch off capability“- requirement)
  - Considered Eye point: [V2 point] (to be discussed)

2. Define the cases when the requirements must be considered (e.g. optional display vs. displaying mandatory information)

[put to UNECE R121?]

- If an HUD and/or FVA system is the only location to display mandatory information, and in case there is no fallback display location, the following provisions must be met:
  - It must be possible for a driver within the scope of ergonomic considerations to adjust seat, steering wheel and HUD/FVA system in a way that the mandatory information can be seen uncut from actual eyepoint (different to V2-Point requirement considering coverage discussion)
    - [within a minimum Eyepoint movement range of +/- 10 mm in Z direction and +/- 10mm in Y direction for both eyes]
  - Minimum brightness for displayed mandatory symbols at all time must be [x cd/m² at the center eye point and y cd/m² at the worst eyepoint within above scope]
  - Minimum brightness regarding to forward outside brightness (insert graph)
  - Mandatory symbol design requirement has to be changed, as black color cannot be displayed, instead black equals transparent ind HUD and FVA systems.

3. Define positive requirements for HUD and FVA systems

a. minimum brightness if switched on
b. Readability
c. optical quality requirements
d. Eyebox size
e. minimum virtual image distance for FVA systems – also consider that holographic or 3D displays may have low physical VI distance but Image can be seen further away by the human eye

→ refers to UNECE R121: matter of changes?

4. Define negative requirements for HUD and FVA systems

a. maximum brightness at night (and how to measure, e.g. against forward brightness)
b. HMI requirements regarding coverage
c. visibility from outside [example: an OLED display in windscreen could be seen by and distract other road participants, therefore not allowed])
d. UNECE R48 defines what is allowed to be seen outside of the vehicle – it must be considered for FVA solution (address outside visibility/outer road user annoyance in case FVA content could be seen from outside – largely depends on displaying technology)

→ refers to UNECE R48: matter of changes?

5. Generate logic structure/clusters as basis for future discussions

a. Define common and different requirements for:
   - dynamic driving task in responsibility of driver
   - dynamic driving task in responsibility of car
   - R157 already has existing definition – is there a need to define similarly for **static** driving task?

b. Address the difference between „optional“ systems and such that are the only place to display mandatory information
   - clarify if FVA has to be considered at all for mandatory information or if such information would only reside in the area of classic HUD displays (static symbol area)
   - Consider, that typically both (FVA contents and static contents) are being provided by the same HUD system; do we then need to distiguish between requirements for mandatory symbols in static symbol area and FVA?

Check R121 regarding interaction with our requirements in R125

[not scope of UNECE R125 – focus on forward vision]

6. Additional points to be discussed

- Discuss: JAMA currently would allow e.g. speedometer above Area S
- Discuss: [remove area S requirement considering M, N and L categories to stay compatible, and keep area S requirement just for physical objects as in current scope of R125?]
  - Is there any benefit to keep area S requirement for HUD/FVA systems, or is it enough to keep area S requirement for physical obstruction?
  - If area S requirement would have to be kept for HUD/FVA systems, it would become necessary to define such area also for the other categories M, N and L!
  - But keep in mind that area S currently is a matter for approval of existing vehicles
  - If Area S requirement should be kept: Actual overlay of used pixels vs. area S must not exceed 20%

- Find a wording for FVA and HUD (e.g. systems that are displaying information in the transparent field of vision)

7. link to R10 for electromagnetic compatibility (EMC) and R151 for side vision

- check if some cross reference needs to be considered

Framework for upcoming discussion

What was discussed last time (Kick-off)

- Short overview of slides 1-11
- Slides 12-27 added <u>after</u> Expert Group meeting on technical requirements (IWG-FVA#2, Jan.18) and industry meeting Jan.26

Statements for further discussion

- FVA systems will usually contain „classic“ HUD symbols as well
- Those static symbols like vehicle speed, speed warnings etc. should be handled identically as for current HUD systems, therefore we need to clearly differentiate between HUD content and FVA content that will typically occur both within an FVA system.
- There is a request from some car manufacurer to allow such static symbols also within FVA area (above area S), e.g. vehicle speed
- This is explicitely not intended by RDW → placement within area S sufficient?

Mandatory information #1

If an HUD or FVA system is being used as the only location for displaying one or more mandatory symbols (e.g. car without instrument cluster but HUD/FVA), then it is necessary to ensure that this information can be seen at all times

- Matter of UNECE R121? → new requirement(s) for such cases
- It must be possible to see the virtual image of those mandatory symbols uncut (within the possible drivers eye positions defined by car manufacturer)
- If the system contains an adjustable eyebox (=area where driver can see an uncut image), the adjustment range of the system for the display area of mandatory symbols must contain all eye above positions

Mandatory information #2

If an HUD or FVA system is being used as the only location for displaying one or more mandatory symbols (e.g. car without instrument cluster but HUD/FVA), then it is necessary to ensure that this information can be seen at all times

- Either it must not be allowed to switch of a HUD/FVA system that displays mandatory information
- Or there must be a fallback display location
- Or the HUD/FVA system must switch on automatically to display the mandatory information (typical switch-on-time: ~2-5s), it needs to be clarified if that time is sufficient
- If switch-on-time of 2-5s is not sufficient, the system needs to remain in a pre-activated state (e.g. adjustable mirror in operating position) while being switched off and while ignition is on

Mandatory information #3

If an HUD or FVA system is being used as the only location for displaying one or more mandatory symbols (e.g. car without instrument cluster but HUD/FVA), then it is necessary to ensure that this information can be seen at all times

- The minimum brightness of mandatory symbols must be high enough to be clearly visible against outside [forward] brightness, and dark enough against outside [forward] brightness not to blind the driver
- The symbol definition for mandatory symbols needs to be adapted*, e.g. “red sign on black background” needs to be redefined: “for HUD/FVA application, any ‘black background’ requirement for mandatory symbols is being replaced by ‘transparent background’ (that is for technical reasons, as black corresponds to no light in HUD/FVA systems, and no light means transparent)

* remark: the intention of ‘black background’ may be to ensure the highest possible contrast/best readability. For HUD/FVA systems the best contrast is being reached against transparency. Actually, black symbol background setting in software leads to transparent symbol background. It is necessary to point out that it is not possible to display black color with a HUD/FVA System.

INTERNAL

Mandatory information #4

Address the difference between „optional“ systems and such that are the only place to display mandatory information

- clarify if FVA has to be considered at all for mandatory information or if such information would only reside in the area of classic HUD displays (static symbol area)
- Consider, that typically both (FVA contents and static contents) are being provided by the same HUD system; do we then need to distiguish between requirements for mandatory symbols in static symbol area and FVA?

Digital delay requirements [define limit values]

Due to electronic processing of sensor signals and digital signal transmission and display properties, there is always a delay between intended time of display and actual visibility (scope: high level, system security - not system quality)

NOT NECESSARY

- Maximum allowed delay for FVA content that is intended to overlay objects in the real world (i.e augmented highlighting of other road users) to prevent distraction and misunderstanding [500ms]
- Maximum allowed delay for mandatory warning symbols to ensure proper driver reaction [2s]

- Better define at high level requirement (as this is more a quality requirement than an actual risk that could be expected)

Virtual image distance requirements for HUD and FVA systems

- For ‚classic HUD Systems‘: no minimal virtual image distance requirement, as instrument cluster would always be closer than HUD virtual image distance
- For FVA systems: no minimal virtual image distance requirement, as VI distance is mostly an aspect of system quality and thus up to the car manufacturer. There is no „danger“ if a system has a low VI distance, from a high level point of view.
  In reality there is a strong link to eye accomodation time and 3D overlay quality, but an instrument cluster typically is displaying ist content closer to the eyes, so there is no need for a minimum limit from safety point of view.
- Exeptions for HUD- and FVA systems with variable image distance and dynamically moving objects, applicable while the driver has to maintain a dynamic driving task :

NOT NECESSARY

  1. For systems (e.g. holographic systems, 3D displays) that allow virtual image distances to be within the car, it must be prohibited to show content [closer to the drivers eye than the distance from (car manufacturer design-) eye point to the steering wheel]
  2. for systems with variable image distance and dynamically moving objects that allow displaying of objects closer than [2m] in front of the drivers eye it must be prohibited to move displayed content/displayed objects towards the driver faster than [1,5x] of driving speed to prevent that the driver mistakes the object as real object and takes action to ‚avoid collision‘.
  3. Clarification: above exceptions #1 and #2
     - Do not apply during vehicle stand still (static driving task)
     - Do not apply during autonomous driving if the driver is not maintaining any driving task
     - Do not apply for take over requests during the transition from inactivity or a static driving task to a dynamic driving task, as they explicitely have the intention to alarm the driver and such effect could be used positively to emphasize the take over request.

- Further discuss influence of accomodation time to wrap up the topic (comparison to CID and FID which are closer and take more accomodation time than an hypothetical FVA with very close VID (e.g. 1m).
- Find definition of accommodation time

Visibility from outside

If a display technology allows visibility of content from outside the car, other than through back and side windows (just as for instrument clusters):

- it must be ensured that light color emitted towards other road users complies with the regulations for outside lighting
- it must be ensured that law enforcement systems can have an unblocked view to the driver‘s face

NOT NECESSARY

Remark: HUD and FVA systems usually have a very small acceptance angle and it is close to impossible to see the content from outside the car - it therefore can be benifical to use such systems to display information that needs to considered as private information, if such regulations would apply to displayed content (data and information security, GDPR compliance regulations etc.)

Not necessary to consider because of small accaptance angle (=from where someone outside of the car could see image contents of an HUD/FVA system)

Exeption: e.g. OLED inside of windshield could emit light to the outside and prevent law enforcement cameras from seeing the drivers face. Also to check: thermal influence could prevent infrared cameras from seeing within the car

Double check regulations for reflective coatings of windshields (corresponding to other regulations?)

All requirements regarding this will be most likely addressed in windshield regulations (UNECE R43) and are not within scope of FVA.

R118 for M3 vehicle category (→ to be reviewed in literature group)

Discussed up to here on 24.03.2022

Maximum brightness against [forward] outside brightness for [HUD] and FVA systems

- Measurable criteria needed for type approval?
- A maximum brightness value within that scope must be very high so that it does not interfere with minimum contrast requierements e.g. for mandatory symbols, and to allow good readability in normal use cases
- A good approach would possibly be to leave the dimming curve application up to the car manufacturer, if the system has additional functions that reduce brightness or switch the system to a safe state in case of electrically detectable failures regarding brightness of displayed content (e.g. in case of an error that leads to a full white image or a full colored image)
- If the system does not have any error detection of display content / image brightness, a ‚maximum dimming curve‘ may be matter of discussion to ensure basic safety.

Extending the scope of automatic shut-off capability

- The wording:

  5.1.3.6. The FVA shall be deactivated automatically in case of an electrically detectable failure of the FVA that affects the visual information as an identified risk considered in the safety approach.”

  should be modified to allow switch-off **and alternatively fallback to safe-state**:

  5.1.3.6. The FVA shall be deactivated [or switched to a safe state] automatically in case of an electrically detectable failure of the FVA that affects the visual information as an identified risk considered in the safety approach.”

- Reference from UNECE R100 provided by Eddie
- Define high level requirements for safety based on ISO standards
- 5.1.3.6. should not be required to latch over the drive cycle if it is a intermittend failure (Michal Macuda will check)

A written explanation describing the basic operation of the vehicle controls that manage REESS operation. The explanation must identify the components of the vehicle control system, provide description of their functions and capability to manage the REESS, and provide a logic diagram and description of conditions that would lead to triggering of the warning.

UN-R 116 annex 11 : A risk reduction analysis using functional safety standard such as ISO 26262 and safety of the intended functionality standard such as ISO/PAS 21448, which documents the risk to vehicle occupants caused by revocation of a digital key and documents the reduction of risk resulting from implementation

Discussed up to here on 14.04.2022

Manual switch-off capability

nd	5.1.3.5.5. It shall be possible for the driver to switch off the FVA by a direct deliberate action consisting of at least one manual option with maximum of 2 consecutive steps. Intuitive action (e.g. double press, swipe and press) is considered as a single step. This provision does not apply when the vehicle is in a backing event as defined in UN R 158.	TR

Add additional exclusion for high priority warnings?

- …witch off the FVA by a ~~direct~~ deliberate action …m of 2 consecutive steps. Intuitive action (e.g. …le step.
  …l can be omitted during backing up). The two-step-approach …quires priority overlay of e.g. a touch button.] R158 RVCS camera …me the matter can be handled as for reverse gear.

as … full screen that can have a higher priority than touch buttons for sys… in the forward fields of vision while backing up (driving backwards or at sta…
This wo… a voice recognition (as Mercedes Benz uses it for two-step-approach) may not be available in reverse gear.

- To discuss: how will high priority warning overlays be handled?
  E.g.: a system has a two-step touch button approach for switching off FVA manually, but a high temporary priority warning is issued according to regulations, that overlays the corresponding touch button: is it allowed then to first click or swipe away the high priority warning, effectively adding a third step?
  If not: how to handle priority warning overlays then?

Suggestion to (re)discuss in the group on 04.08.2022:
conclusion on final wording and planned date for amendment
Add additional exclusion for high priority warnings?
Comment: careful wording needed to prevent combination effects of exclusions, e.g. backing event AND high priority warning

There is no category for driver related or car related warnings This leads to removal of a lot of useful warning contents:

Example from AUDI/Porsche: **57** warnings to support or gain driver awareness had to be removed from HUD completely due to Area S requirement and insufficient space in lower area for such warnings (they contain text + warning symbol)

Some examples that were planned in AR-HUD and now had to be removed completely from HUD:

- All emergency assist warnings had to be removed:
  - Driver inactivity detected: take-over-request for driver: **NOK**, removed
  - Emergency assistant is active: take-over-request for driver: **NOK**, removed
  - Emergency assistant: automated emergency braking is activated: **NOK**, removed
  - Emergency assistant: automated emergency lane change is being issued: **NOK**, removed
- ACA terminated: take-over-request for driver: **NOK**, removed
- ECE-R79 Hands-Off-Cascade: Level 1: take-over-steering request for driver: **NOK**, removed
- ECE-R79 Hands-Off-Cascade: Level 2 Warning: take-over-steering request for driver: **NOK**, removed
- System limit warning ACA lane keep assistant: take-over-steering request for driver: **NOK**, removed
- HCA: take-over-steering request for driver: **NOK**, removed
- aLDW automated lane departure warning: take-over-steering request for driver: **NOK**, removed
- aLDW request to drive centered in lane: **NOK**, removed
- Wrong way warning: **OK**
- All Parking assistant warnings (e.g. function drop off): : **NOK**, removed
- precrash-system activated: **NOK**, removed
- Cross traffic warning**:** **OK**
- Oncoming traffic warning: **OK**

→ Are we sure that this effect meets our intention?

Suggestion: add category for driver awareness warnings and high priority vehicle warnings

Examples for Warning / Highlight / Information as specified in paragraph 5.3.5.1.:

	Examples
Warning/Highlight hazardous traffic situation	Abrupt braking situations Oncoming traffic in turning manoeuvres Oncoming traffic jam/vehicle break down Vehicles leaving the lane or entering the own driving path
Warning/highlight vulnerable road users or other road users which may be overseen	Pedestrians Cyclists Crossing road users Road users in blind spot or road users covered by other objects Animals
Information to maintain the distances to surrounding road user and infrastructure	Distance to vehicle in front Lane keep assist, lane change assist, speed limits changes
Information to find and maintain the correct driveway and to follow the road instructions	Navigation Information, symbols and arrows during automatic lane change (Directions, remaining distance to target, border crossings) Highlighting stop lines and pedestrian crosswalks
Warnings that require drivers immediate action	**take-over-steering request** **activity of emergency assistants, e.g. emergency stop is active, emergency lane change is active** **Battery overheat – stop vehicle immediately** **High voltage system failure – stop vehicle immediately**
Critical warnings that require drivers immediate attention	**Lane keep assist: function drop off due to reduced sensor vision** **o: system error warning (only critical in case of a parking event)**

Conclusion: Add in 5.1.3.5 (double check paragraph #)

Add f) Warnings that require drivers immediate action
g) Other critical warnings that require drivers immediate attention

And add examples to annex 5 as shown here: →

Add such categories

Discussed up to here on 04.08.2022

Level 3 / Level 4 regulation

Suggestion to (re)discuss in the group on 04.08.2022:
Add definition for automated driving
→ R157 as reference for existing text
→ Consider take over request for level 3

Suggestion: in case of automated driving (where driver is not required to have attention on the road): No restriction in content, but in case the autonomous driving level can issue a take-over-request to the driver, those additional contents must be **switched off** upon such take over request or any other required warning (Also vehicle related like battery overheat etc.) and a warning must be displayed in the FVA instead of that content to support drivers awareness (additional places of display like e.g. the FID or CID are also allowed)
In case the underlying condition for the warning disappears and the attention of the driver is not required anymore, the additional content may be switched on again (e.g. a paused video may be resumed afterwards)

Trucks/busses: suggestion:

Suggestion to (re)discuss in the group on 04.08.2022:
Add scope for heavy duty vehicles:
e.g. for this vehicle category, FVA and HUD systems are explicitly allowed
Restrictions: only driving related but **+ warnings,** and without area restriction (for now)
Additionally: exclude such systems from being a coverage for the upcoming forward field of vision regulation for this vehicle category, and instead track the limitations and definitions within our scope of regulation.

Aim: allow HUD and FVA systems for trucks & busses
Restrict only when risk is identified (high level approach)
Allow additional vehicle- and work related content **during standstill even while engine still running/vehicle master switch still on** (e.g. vehicle information like air pressure, position of lift arm, activity of cement mixing etc. as well as next customers, necessary arrival time for delivery, text information from bosses office on updated workday schedule etc.)
Additionally allow further content like video/email/internet/films during standstill when parking brake is being applied, e.g. watching a video while parking – but still in this case engine my be required to be running, e.g. because the truck carries cooling goods where the AC system must be active and thus the engine must be running → but parking brake must be applied. Maybe add timeout of 10 seconds or 2 minutes or prevent watching a footballgame while waiting at a red traffic light.

To discuss: could be misused in traffic jam (but also in light vehicles e.g. watching TV is allowed during standstill, so it may be no issue)

Considerations for other vehicle categories:

- *There is no Area S definition for other vehicle categories, therefore some other regulation must be found, e.g.:*
- *[for M2-M3/N2-N3 vehicles: The FVA contents are handled as for category M1 (i.e. only driving related).
  Provisions for image content that is outside the scope of FVA systems: such content may not be displayed at a image position whose bottom image border could cover the road closer than 5m to the front of the vehicle, indicated from a seating position considered as standard position (estimated mean position of drivers eyes) by the manufacturer, to prevent coverage of other rod users (e.g. pedestrians) while maneuvring the vehicle.
  The image contents outside of scope of FVA systems at a vehicle speed above 30 km/h may be displayed in an area whose upper image border does not cover the road in front of the vehicle further than 10m in front of the drivers eyes (seating position as indicated by manufacturer).
  Alternatively or additionally, the bottom image border may be above +1 degree of horizon or up to and outside of [illegible] grees to the side of the seating center of the driver, as indicated by the manufacturer.] (omit grey in favour of augmented [illegible]*
- *[For helmets in category L vehicles: The symbols within FVA and als[illegible] FVA may cover not more than 30% of an FOV of 20°x20° (W x H) divided in 2°x1° areas where [illegible] may exceed 50% coverage and no 2°x1° areas next to each other may exceed 30% coverage in [illegible] of a driver, wearing the helmet as indicated]*

To discuss in the group on 13.07.2022 - updated discussion basis see slides below

Considerations how to handle non-existing Area S definition for other vehicle categories

To discuss in the group on 13.7.2022

Area S definition within UNECE R125 initially focussed on permanent coverage e.g. by steering wheel, Instrument panel etc. and was taken over for HUD – is this necessary for safety approach regarding HUD systems, where in the FVA region content is not permanent?

Two possibilities to discuss:

1: Instead of finding an Area S definition for other vehicle categories, we could omit Area S for FVA and find different approach to ensure safety

Benefit: less problems with existing systems, e.g. many warnings like take-over of steering are currently not allowed above Area S and need to be made smaller to fit below, without actual benefit for driver safety

2.: add warning category (and examples) to the scope of allowed content in FVA region above Area S and also find area S definition for other categories

Benefit: same as above, but area S definition e.g. for helmets may be difficult

If going for option 1: we could redefine FVA to be dynamic content instead of "above area S" (as opposite to "static" content for normal HUD systems) and make requirements regarding content based on **accepted** use cases.

E.g.: in the area of FOV where only dynamic content is being displayed, the current provisions on content apply, but additionally (re)discuss to allow warnings (vehicle warnings as required in FID, driver awareness warnings like the request to take over steering etc.) which would benefit the driver (larger warning, higher awareness)

Additionally, discuss benefit of content that helps the driver to be less distracted from traffic while maintaining additional tasks (that are allowed to do) and that the driver issued himself (e.g. start phone call, select radio station), as the alternative for the driver would be to look down to center display or mobile phone, which would distract even more) - but still ensure that no unnecessary content is being displayed.

Unnecessary content would be content that was neither requested by the user nor has to be displayed by law.

Considerations how to handle non-existing Area S definition for other vehicle categories

To discuss in the group on 13.07.2022

Examples:

REQUESTED BY LAW: if a take over steering request is issued, it would be displayed in FID anyhow, and the driver would look down to FID. Better to allow doubling that to FVA area?

USER-REQUESTED: If user wants to switch radio station, he will do that anyways, and it is currently already allowed to do so in other displays as well as standard HUDs. Discuss: is there a higher risk when displaying such list in FVA area?
Argument against displaying only in area s: list length would be one or two rows only (in many cases), and **current HUDs e.g. like from BMW already show lists with more rows – an FVA system typically has less lookdown angle and would therefore require to cut the number of rows due to area S restriction (while standard HUD could also be set by drive to have same lookdown angle as an FVA system** (be in same area, but allowed - as this would not be center position as indicated by manufacturer)

That means an FVA system effectively may display less content than an HUD system, just because center position as indicated by manufacturer is different. That is somehow inconsistent.

UNECCESSARY and not allowed: it shall NOT be allowed to show content that was neither requested nor is necessary, e.g. POI information during manual driving, advertisements, or information that are not helping the driver to maintain the driving task and/or to maintain other tasks that are allowed during manual driving and issued by the driver.

A "Please charge phone"-warning would not be allowed in scope of FVA area because neither requested nor necessary, but "immediately stop car"-warning could be allowed then as it needs to be displayed anyhow and driver should react.

As a summary: discuss additional category of allowed FVA content: content related to necessary warnings and tasks that are allowed during driving, which helps the driver to be less distracted (e.g. by providing a better display location than looking away from road).

To ensure that no OEM just increases symbol sizes unnecessarily, the wording could be: it is also allowed to display content related to vehicle, driver related warnings as well as content requested by the driver, as long as displaying such content in the area of FVA leads to less distraction time and/or as long as there is a benefit in readability opposed to displaying only within Area S or other displays while causing no additional risk.

Example: a more prominent take over steering warning can be an argument opposed to not displaying it in AR-HUD system at all due to area s restriction

Considerations how to handle non-existing Area S definition for other vehicle categories

To discuss in the group on 13.07.2022

Suggestion to solve issue of missing area S definition in other vehicle categories:

Remove relation of FVA definition to area s, instead focus on actual difference between HUD and AR-HUD:

- HUD has "static content"

- AR-HUD also shows content related to objects in outside world, and therefore also displays content with less lookdown angle (towards horizon, to be able to highlight road and other road users).

Static content as for normal HUD systems (without content restrictions) could then be allowed below [1,5°]* look-down angle (or above [1,5°] look-up angle) from **center eyepoint as indicated by manufacturer**, while anything within (direct front field of vision) would fall under the current restrictions for FVA systems, but with the addition of temporarily required warnings or user requested (and allowed) tasks and (in case of manual driving) a reduced distraction time can be achieved.

That would also cover that a user could request watching a film or reading emails in that area in case of automated driving, **if such tasks are allowed,** e.g. from level 4 driving onwards.

The same definition would then be transferred to other vehicle categories, where e.g. in trucks the "static content" may benifically displayed above horizon instead of below (due to technical limits).

For motorcycles and AR glasses such area (+/- [1,5°] from horizion line) can be easily detected, allowing to keep conform to the regulation, effectively having the same requirements for all types of vehicle categories.

Solves: partial or full image cut issue from V2 point for HUD systems (as brought up by JAMA), missing area S definition for other vehicle categories, and solves issues with existing HUD systems that can currently fall under FVA regulation (which was not intended), as well as restrictions for FVA systems when considering tolerances (see separate example image that may be shown but not shared)

To discuss for helmets and AR glasses: should "static content" be fixed to drivers head movement or stay fixed in reference to horizon?

Suggestion to discuss: should move with head, as e.g. motorcycle drivers may lower their head depending on motorcycle type, which could lead to situations whre static content as e.g. vehicle speed could then not be seen. The additional benefit would be that in case something in outside world would be overlayed, a small head movement would be sufficient to solve that (and is intuitive for the driver).

This also solves the issue of horizontal positioning, which would somehow have to follow curves on the road and may be difficult to predict – if fixed to head movement, that problem is automatically solved.

****value derived from a worst case standard HUD system of 3° LD-angle and 3° VI height that would leave 1.5° below horizon line free of content. Usually normal HUD systems have more LD angle, but for sports cars this would be a possible value setting that would currently be allowed regarding area S limitations, thus taking this as a reference.***

Find a wording for FVA and HUD (e.g. systems that are displaying information in the transparent field of vision)

- There is some ISO standard that has example definitions for HUD, AR-HUD etc. – take definitions from there?

Suggestion to discuss in the group on 13.07.2022 - see above slide

Literature/administrative subgroups: check references

- UNECE R158
- ISO 26262: check for HMI requirements regarding coverage referring to functional safety
- Within GRSG, functional safety was introduced recently in R116 (1st series introducing Digital Keys): there both ISO 26262 & 21448 (SOTIF=safety of intended function) were introduced

(annex 11)

- UNECE R10 for electromagnetic compatibility (EMC) or other regulations e.g. R151 for side M2M3N2N3 vehicle detection and alert of a cyclist.
- UNECE R46 annex 12 (functional safety of digital view)

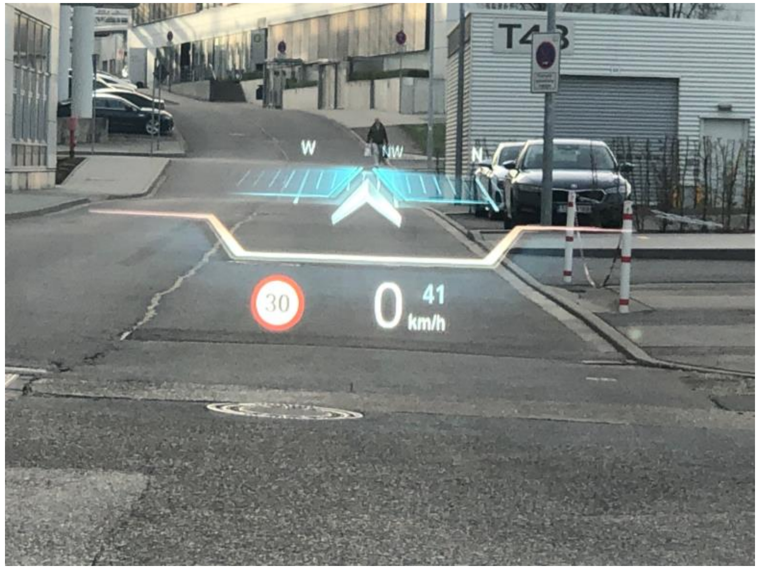
Contains examples of testing (type approval authorities can inject defined test pictures)
→ input from literature group: adapt for FVA

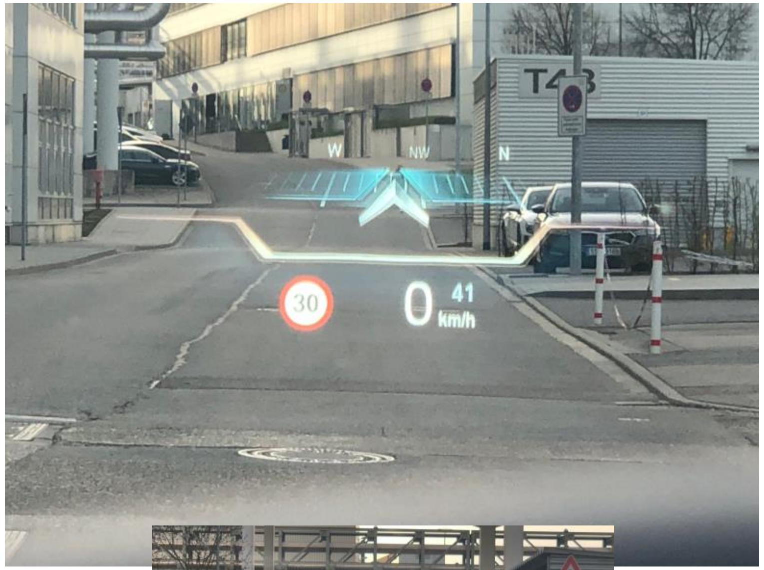
Technical Expert Group 14.04.2022

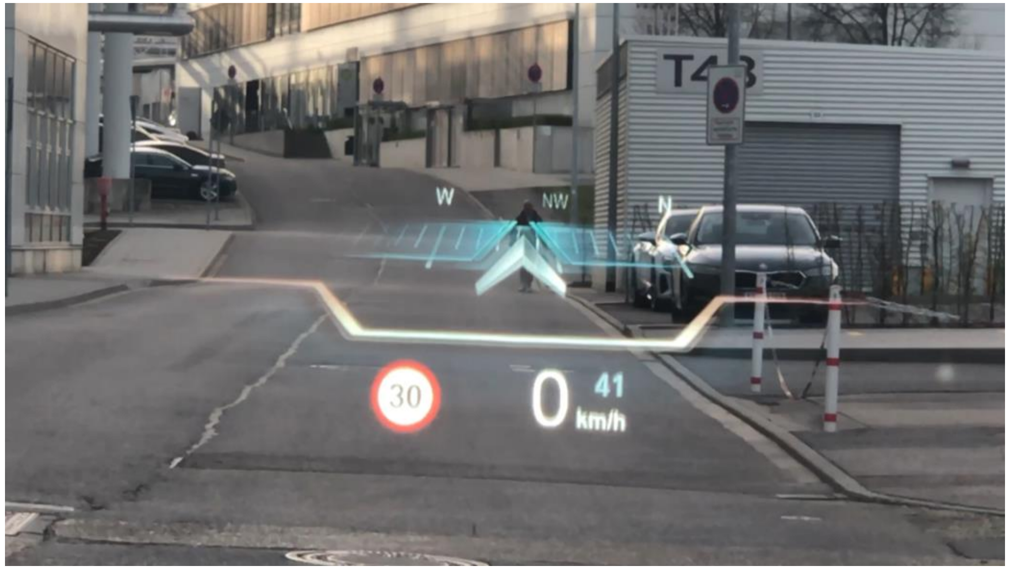
- Scope of today‘s meeting:
- Finish slides from last meeting (Slide 23-29)
- Discuss coverage criterion
- Explain luminance vs. RGB colors
- Discuss no-go test pictures as a first shot for coverage
- Discuss independent brightness criterion as a first shot for blinding prevention

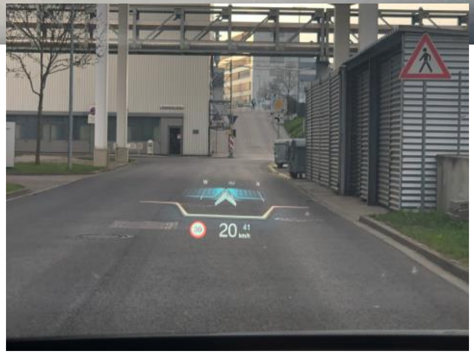
Coverage criterion

Example of series HUD in a situation where the car is standing in front of an inclining street

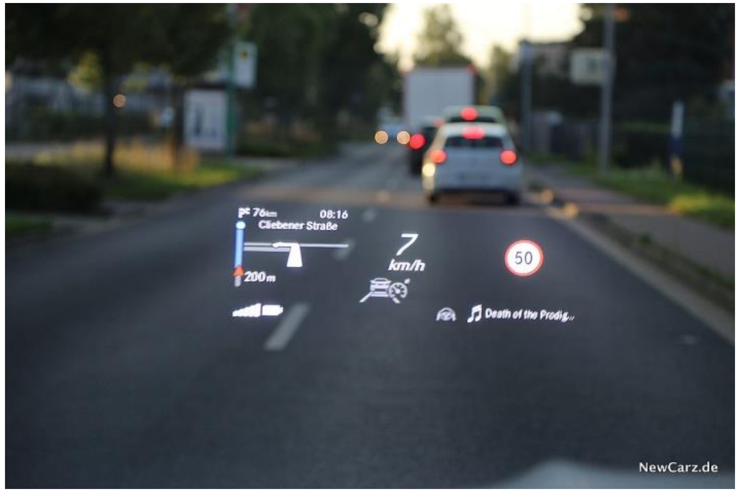


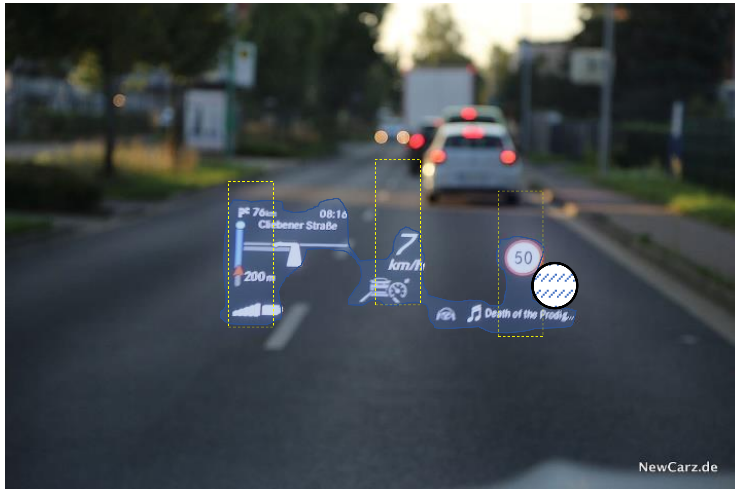


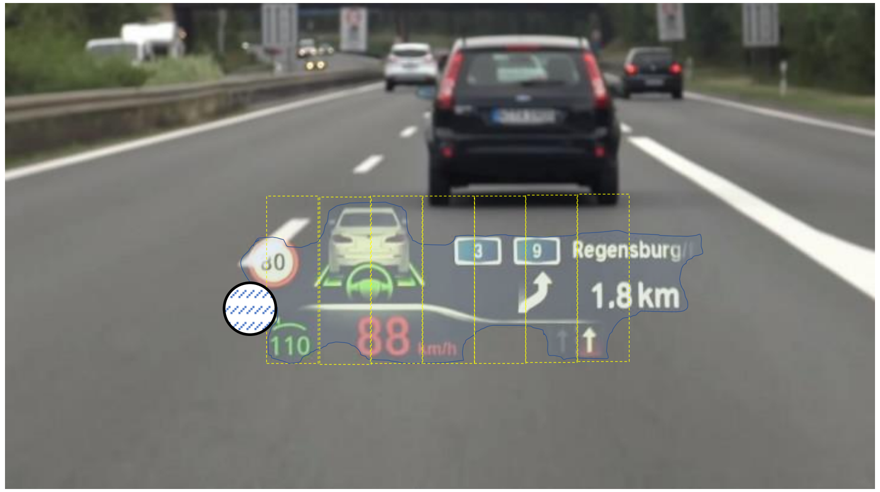


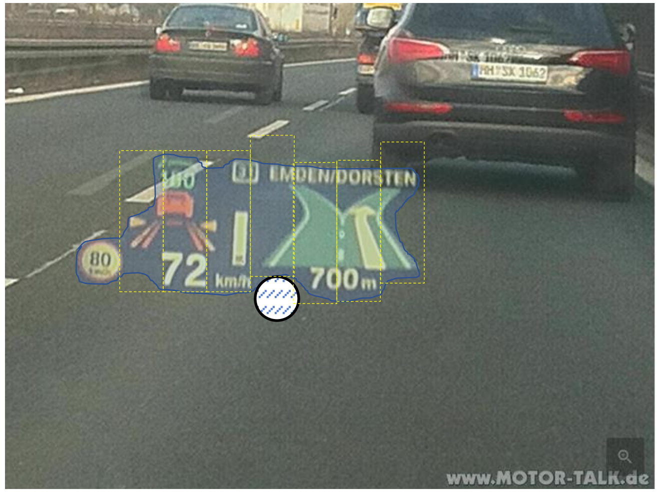


JAMA V4 violation examples of series HUD HMI #1









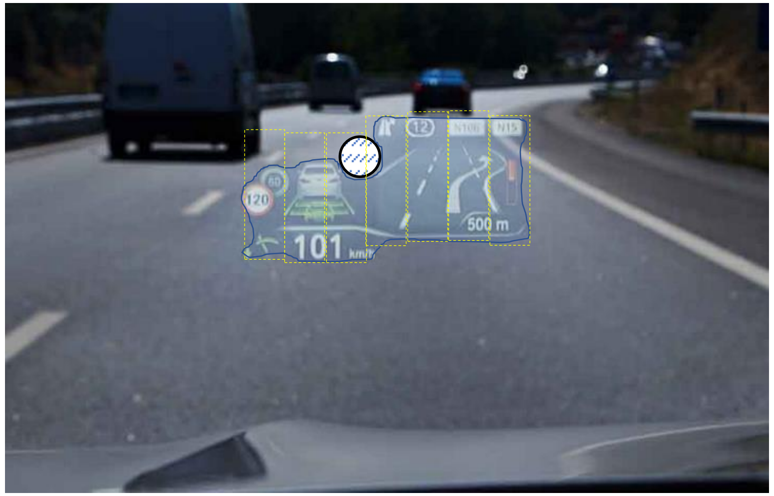
violating JAMA V4 envelope (3x)

violating JAMA V4 envelope (7x)
violating JAMA V4 red criteria

violating JAMA V4 envelope (7x)

*using HUD images instead of FVA images as not many images/systems available yet

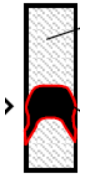
JAMA V4 violation examples of series HUD HMI #2



violating JAMA V4 envelope (7x)
violating JAMA V4 red criteria

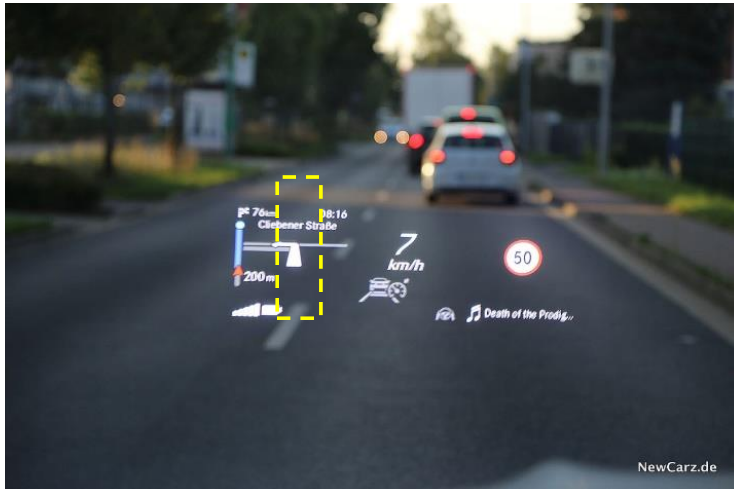
violating JAMA V4 envelope (2x)
violating JAMA V4 red criteria

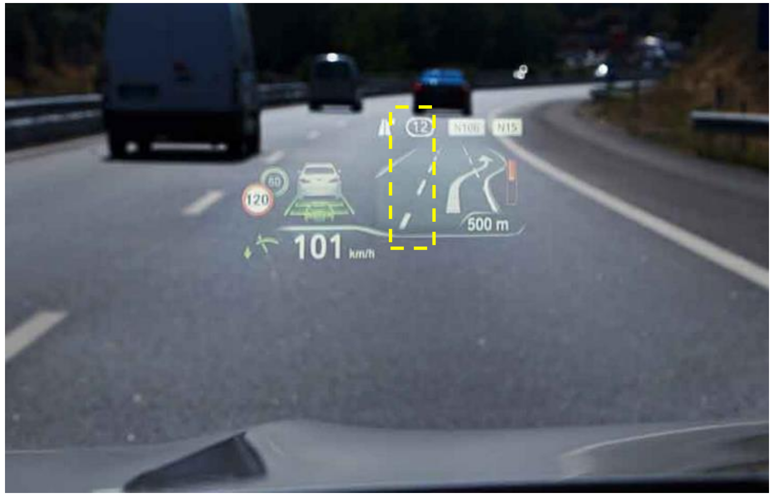
*using HUD images instead of FVA images as there are not many images/systems available yet



questioning the envelope concept in detail

Is it true that with such clean HMI concepts a pedestrian in size of yellow box (basic figure: 2,6°x 0,8°) could **not** be seen?



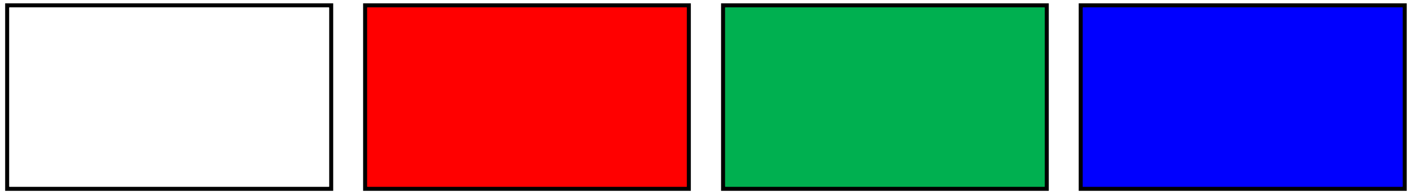


All examples above are static images and do not even consider the relative movement of the car relative to a pedestrian of such size, which will make pedestrians even more recognizable due to constantly changing perspective.

Remark: Test setups/studies with virtually driven cars by using screens that have no 3D depth are not even close to FVA/HUD system behaviour in real world

no-go test pictures as a first shot for coverage

Full RGB colors



white 255 red 255 green 255 blue 255

…must be prevented by the FVA system itself

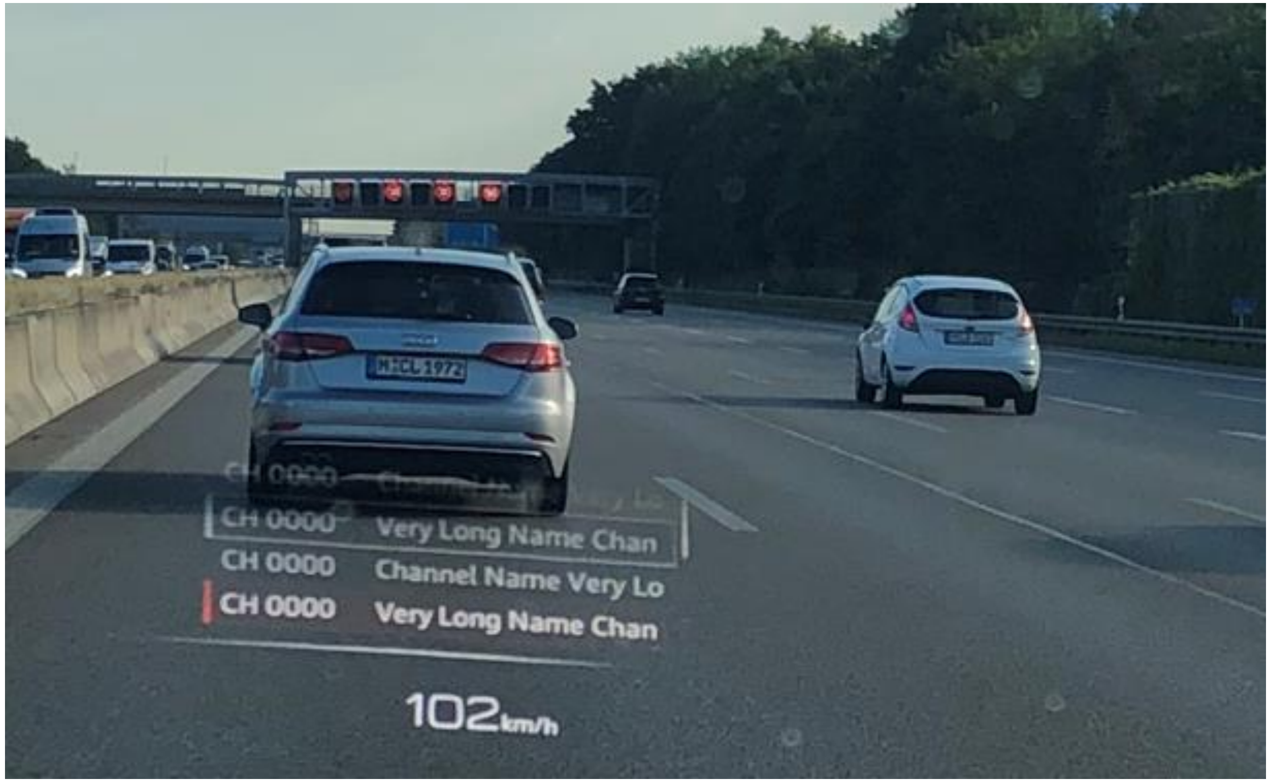
+ Missing image signal must lead to a default black image

Luminance vs. RGB colors

- See separate word document

Example of media list

- We currently do not allow media lists above Area S in nominal HUD setting. Nevertheless, the content can be adjusted way above Area S, also with almost every conventional HUD that has been on the market since.



→ The alternative is that the driver looks down to the central display to make the settings.

Examples why a criteria that requires a certain transparency would not be useful

Technical Expert Group 13.07.2022

- Scope of today‘s meeting:

•Rediscuss slides 26-29

•Schedule next technical expert group – suggestion: 04.08.2022 / KW31 in general

•Discuss coverage criterion – do we need it at all? à classic HUD can effectively be placed in the same area by adjustment since >10 years, and there are no known problems in the market

•Explain luminance vs. RGB colors

Trucks and Busses

•Scope for next technical expert group meeting:

•Start discussion of other vehicle categories and how to go on with Area S requirement, especially for those vehicle categories

Technical Expert Group 04.08.2022

- Scope of today‘s meeting:

- discuss slides 26-32, slides 45 & 46 optionally

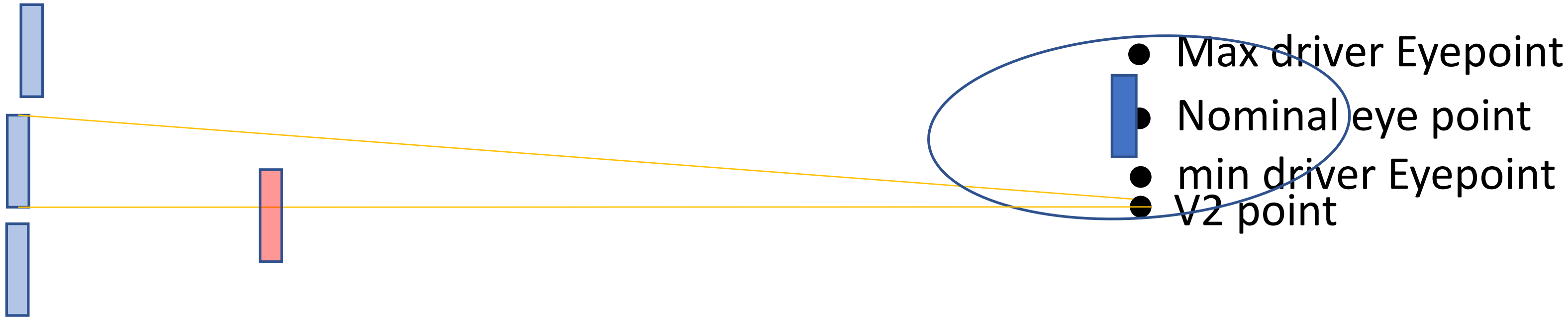
Technical Expert Group 01.09.2022

Scope of today‘s meeting:

- answer slide 49
- discuss slides 50-54
- When and how will the agreed adaptions be implemented? By an amendment, in force from Sept. 2023?
  - backing event exclusion for two-step approach (slide 26)
  - (critical) warning categories (slide 28)
  - reference point clarification (slide 49)

If only a later date of entering into force is possible, how do we handle e.g. cars that are currently legally on the market, would become illegal in sept. 2024 and become legal again when the amendment enters into force?

- ***6.2.2.*** **In the case the FVA position is adjustable, the FVA shall be placed in the normal position indicated by the manufacturer or, failing that, midway between the limits of the range of adjustment."**
- [Add subpoint 6.2.3:] **A fully visible virtual image shall be assumed from V2 point.**
- [Add subpoint 6.2.3:] [The reference point for homologation of FVA systems and [classical HUD systems] is the V2 point – in case the Image contents are cut off (partly visible or not visible at all) from that eyepoint due to system restrictions, the tests shall assume a fully visible image content from that point, and the regulations shall fully apply]



to rediscuss in the group on 01.09.2022: is that added wording for 6.2.3 already shared understanding of the group?

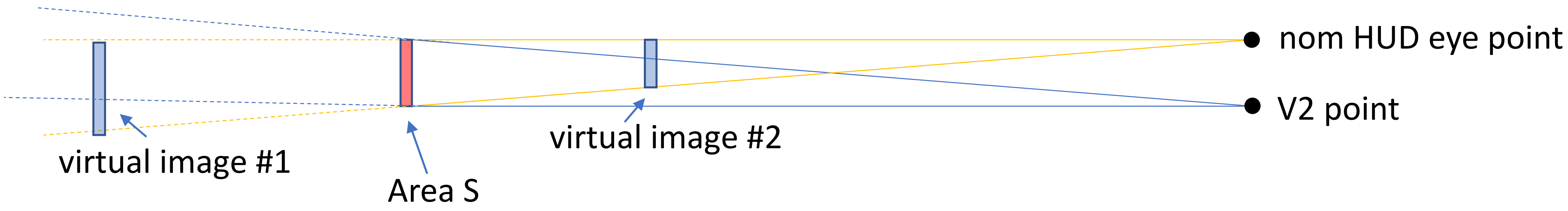
Area S vs. V2 point vs virtual image distance

There is a dependency between the result of Area S coverage and the virtual image distance (VID), which leads to an effect that has been pointed out in previous discussions:

The virtual image of two systems with the same lookdown angle (LD angle) appears in the same position when seen from the actual eye point, **regardless of the VID** – but when calculating the coverage of Area S and the relative position, the result differs depending on the VID, leading to the situation that lower virtual image distances mistakenly seem more critical when calculated from V2 point.

While it is true that the image of a system with lower VID appears higher from V2 point, the behavior of the system when seen from the actual eye point is different. This is happening due to a parallax error.

The following image shows the principle of that effect:



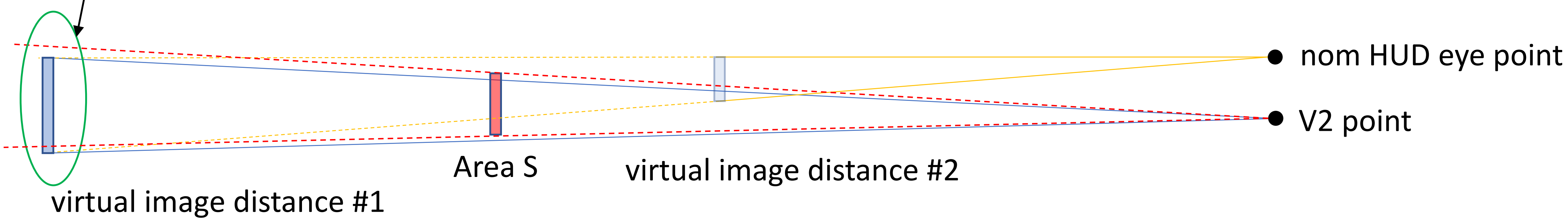
Area S vs. V2 point vs virtual image distance

Case 1 & 2: Situation in two HUD systems with **identical** look-down-angles and different VIDs:

VI = virtual image
VID = virtual image distance

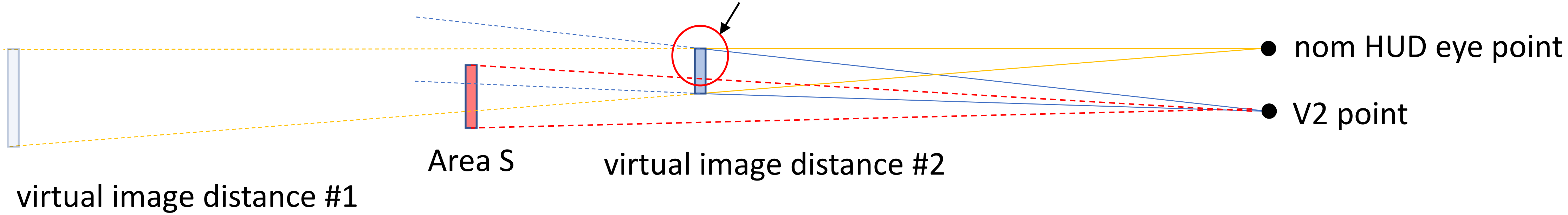
CASE 1: large VID

Large VID: VI not regulated as FVA (VI is inside & below Area S when seen from V2)



CASE 2: small VID

Small VID: 2/3 of VI regulated as FVA (VI is inside and above Area S when seen from V2)



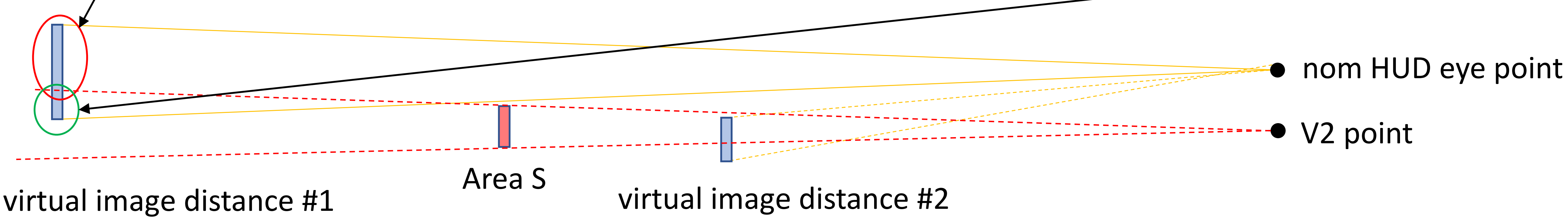
Area S vs. V2 point vs virtual image distance

Case 3 & 4: comparison for classic HUD and FVA systems

FVA systems typically have a larger VID and less lookdown angle (LD is about -2.5° instead of about -5° for classic HUD systems)

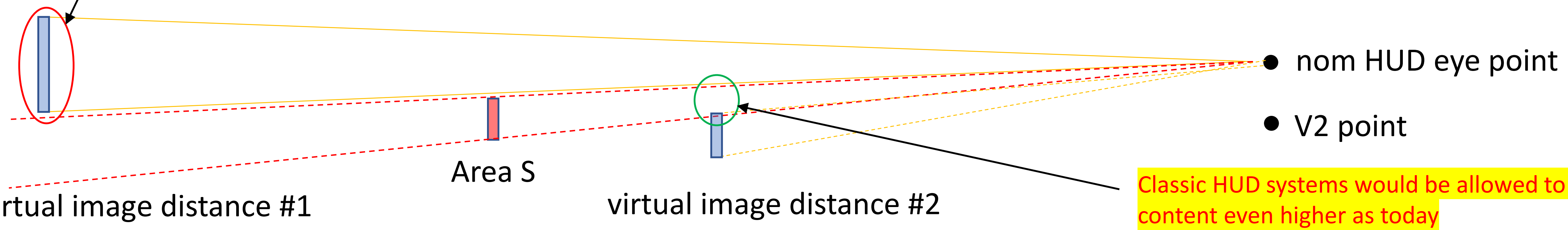
CASE 3: large VID, less LD angle (typical FVA system), investigated from V2 point (current regulation)

Upper part of VI regulated as FVA (VI is inside & above Area S when seen from V2), lower part can show 'classic' HUD content



CASE 4: large VID, less LD angle (typical FVA system), <u>but investigated from eyepoint instead of V2</u>

All of VI regulated as FVA (VI is fully above Area S when seen from eyepoint), **→ 'classic' HUD content in FVA systems would be forbidden**



Classic HUD systems would be allowed to show content even higher as today

Area S vs. V2 point vs virtual image distance

Conclusion: Keep the requirement to calculate from V2 point (as currently defined),
considering that the parallax error will happen for any object that is not exactly in the same plane (i.e. same distance) as Area S.

This ensures that no potential for worsening classic HUD systems is possible and at the same time keeps the possibility to show classic HUD content (static symbols) within FVA systems in the lower area.

Suggestion to discuss in the group

Regulation for trucks, busses and motor cycles draft (as discussed)

HUD and FVA systems are allowed for other vehicle categories.

The provisions for such systems apply as defined but with the exclusion of an area S requirement.

For now, it is therefore the responsibility of the manufacturers of such vehicles to find suitable location fro 'static content' as in classical HUD systems and for FVA content, if applicable.

It is the responsibility of the vehicle/helmet manufacturer to design the system in a way that safety risks are minimized.

Any concerns about safety and their solution should be added to the regulation when found.

There are already concerns to discuss:

- for motorcycles (i.e. HUD systems in helmets) it may be difficult to apply a two-step-approach to switch off such systems (button placement/safe accessibility with gloves). Opening the visor could be an alternative event used to deactivate the system, either electrically or optically.
- For trucks and busses, a requirement to at least aim at positioning static HUD content above, below or sideways of the area of main traffic could be useful. The conclusion in the group was nevertheless to keep the high level approach and only regulate if we assume or find an actual safety risk.
- For Trucks and vehicles used for working, additional content (while at standstill) will be especially helpful, e.g. compressed air pressure etc.
  Problem: in many cases such vehicles arrive at a destination but do not switch off master control switch, e.g. because the engine needs to be running to provide power to peripherals. Therefore it should be allowed to switch on additional content again if such vehicle reaches standstill.
- To prevent the risk of a driver e.g. watching a football game while waiting at an intersection, the immediately allowed content after standstill shall then be limited to technical information and communication related to work purposes (e.g. chat function with company to show next orders or tasks). As some trucks need to have the engine idling even during breaks for the driver, further content e.g. of the entertainment category (TV etc.) shall be delayed by a certain amount of time (tbd, e.g. 1-2 minutes) but also allowed when reaching standstill again.
- To discuss: additional content while driving necessary/useful? E.g. to monitor temperature of a cooling chamber, the fill state of a water tank on a firetruck etc.
  It should be sufficient to think of that as part of the static content area, but such area is not defined in this vehicle category.
  Therefore – in theory – it would be possible to create a large animated image in front of the driver to show such secondary information even during driving.
  As reminded many times, a limitation for such theoretical cases would not follow the high level approach, but we should still discuss this case here.