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Advanced Emergency Braking System

Proposal for an Annex to UN Regulation No. XXX, introducing requirements for an Emergency Motion Inhibit System

Submitted by the expert from Germany*

The text reproduced below was prepared by the expert from Germany. This new Annex on Emergency Motion Inhibit System (EMIS) addresses specifically heavy vehicles being stationary and is aiming at the protection of vulnerable road users. With this UN Regulation, the direct vision regulation could be amended so as to have different performance criteria for vehicles equipped with this EMIS.

* In accordance with the programme of work of the Inland Transport Committee for 2022 as outlined in proposed programme budget for 2022 (A/76/6 (Sect.20), para 20.76), the World Forum will develop, harmonize and update UN Regulations in order to enhance the performance of vehicles. The present document is submitted in conformity with that mandate.

I. Proposal

Uniform provisions concerning the approval of motor vehicles with regard to the Emergency Motion Inhibit System (EMIS) for M_2, M_3, N_2 and N_3 vehicles

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Introduction

[New – not needed if Annex to DV regulation!]

1. [reserved]

2. Definitions

For the purposes of this Annex:

2.1. "*Emergency Motion Inhibit System (EMIS)*" means a system which can automatically detect an imminent forward collision and activate the vehicle braking system to decelerate the vehicle with the purpose of avoiding or mitigating a collision.

2.2. [reserved]

2.3. "*Collision Warning* " means a warning emitted by the EMIS to the driver when the EMIS has detected an imminent forward collision.

2.4. "*Vehicle Type with Regard to its Emergency Motion Inhibit System*" means a category of vehicles which do not differ in such essential aspects as:

(a) Vehicle features which significantly influence the performances of the EMIS;

(b) The type and design of the EMIS.

2.5. "*Subject Vehicle*" means the vehicle being tested.

2.6. "*Soft Target"* means a target that will suffer minimum damage and cause minimum damage to the subject vehicle in the event of a collision.

2.7. "*Bicycle Target*" means a soft target that represents a bicycle with cyclist.

2.8. "*Pedestrian Target*" means a soft target that represents a pedestrian.

2.9. "*Common Space*" means an area on which two or more information functions (e.g. symbol) may be displayed, but not simultaneously.

2.10. "*Self-Check*" means an integrated function that checks for a system failure on a continuous basis at least while the system is active.

2.11. [reserved]

2.12. "*Initialisation*" means the process of setting-up the operation of the system after switching ON the vehicle until it is fully functioning.

3. [reserved]

4. [reserved]

5. Specifications

5.1. General requirements

5.1.1. Any vehicle fitted with an EMIS complying with the definition of paragraph 2.1. above shall, when operated within the speed ranges prescribed in paragraph 5.2.3, meet the performance requirements of paragraphs 5.1. to 5.5. of this Regulation.

5.1.2. The effectiveness of EMIS shall not be adversely affected by magnetic or electrical fields. This shall be demonstrated by compliance with the 05 or later series of amendments to UN Regulation No. 10.

5.1.3. Conformity with the safety aspects of electronic control systems shall be shown by meeting the requirements of Annex 3.

5.1.4. Warnings and information

[In addition to the collision warnings described in paragraphs 5.2.1.,] the system shall provide the driver with appropriate warning(s) as below:

5.1.4.1. A failure warning when there is a failure in the EMIS that prevents the requirements of this Regulation of being met. The warning shall be as specified in paragraph 5.4.4.

5.1.4.1.1. There shall not be an appreciable time interval between each EMIS self-check, and subsequently there shall not be a delay in illuminating the warning signal, in the case of an electrically detectable failure.

5.1.4.1.2. Upon detection of any non-electrical failure condition (e.g. sensor blindness or sensor misalignment), the warning signal as defined in paragraph 5.1.4.1. shall be illuminated.

5.1.4.2. If the system has not been initialised after a cumulative driving time of 15 seconds above a speed of 10 km/h, information of this status shall be indicated to the driver. This information shall exist until the system has been successfully initialised.

The motion inhibit functionality shall be available immediately after vehicle start-up.

5.1.5. Motion inhibit

Subject to the provisions of paragraphs 5.3.1., the system shall prevent the vehicle from moving off from standstill as described in paragraph 5.2.5 when vulnerable road users are present within the close proximity of the vehicle.

5.1.6. False reaction avoidance

The system shall be designed to [minimise the generation of collision warning signals and to] avoid advanced emergency braking in situations where there is no risk of an imminent collision. This shall be demonstrated in the assessment carried out under Annex 3.

5.1.7. [reserved]

5.2. Specific Requirements

5.2.1. Collision warning

When the EMIS has detected the possibility of a collision with a vulnerable road user, crossing the road at a constant speed of not more than 5 km/h, within the conditions specified in paragraph 5.2.4., a collision warning as specified in paragraph 5.4.1. shall be provided no later than the start of the emergency braking.

The collision warning may be aborted if the conditions prevailing a collision are no longer present.

This shall be verified according to paragraph 6.7.

5.2.2. [reserved]

5.2.3. Speed range

The system shall be active at least when the vehicle is stationary and at all vehicle load conditions.

5.2.4. [reserved]

5.2.5. Motion inhibit for stationary vehicle

Whenever a vulnerable road user is in a region, extending from the vehicle front by 1.5 m and extending to the side 0.5 m beyond the side planes of the vehicle, it shall only be possible to accelerate a stationary vehicle by means of two deliberate actions. Any attempt to accelerate the vehicle shall result in a collision warning as per paragraph 5.4.

5.3. Interruption by the Driver

5.3.1. The EMIS shall provide appropriate and robust means for the driver to interrupt the collision warning ~~and the emergency braking~~.

5.3.2. This interruption may be initiated by any positive action (e.g. kick-down or a swerving action that results in enough change of direction to not hit the target) that indicates that the driver is aware of the emergency situation. The vehicle manufacturer shall provide a list of these positive actions to the technical service at the time of type approval, and it shall be annexed to the test report.

5.4. Warning Indication

5.4.1. The collision warning referred to in paragraphs 5.2.1. and 5.2.5. shall be provided by at least two modes selected from acoustic, haptic or optical.

5.4.2. A description of the warning indication and the sequence in which the collision warning signals are presented to the driver shall be provided by the vehicle manufacturer at the time of type-approval and recorded in the test report.

5.4.3. Where an optical means is used as part of the collision warning, the optical signal may be the flashing of the failure warning signal specified in paragraph 5.4.4.

5.4.4. The failure warning referred to in paragraph 5.1.4.1. shall be a constant yellow optical warning signal.

5.4.5. Each EMIS optical warning signal shall be activated either when the ignition (start) switch is turned to the "on" (run) position or when the ignition (start) switch is in a position between the "on" (run) and "start" position that is designated by the manufacturer as a check position (initial system (power-on)). This requirement does not apply to warning signals shown in a common space.

5.4.6. The optical warning signals shall be visible even by daylight; the satisfactory condition of the signals must be easily verifiable by the driver from the driver's seat.

5.4.7. When the driver is provided with an optical warning signal to indicate that the EMIS is temporarily not available, for example due to inclement weather conditions, the signal shall be constant. The failure warning signal specified in paragraph 5.4.4. above may be used for this purpose.

5.5. Provisions for the Periodic Technical Inspection

5.5.1. At a Periodic Technical Inspection, it shall be possible to confirm the correct operational status of the EMIS by a visible observation of the failure warning signal status, following a "power-ON" and any bulb check.

In the case of the failure warning signal being in a common space, the common space must be observed to be functional prior to the failure warning signal status check.

5.5.2. At the time of type approval, the means to protect against simple unauthorised modification of the operation of the failure warning signal chosen by the manufacturer shall be confidentially outlined.

Alternatively, this protection requirement is fulfilled when a secondary means of checking the correct operational status of the EMIS is available.

6. Test procedure

6.1. Test Conditions

6.1.1. Test surface

6.1.1.1. The test shall be performed on a flat, concrete or asphalt road affording good adhesion.

6.1.1.2. The test surface has a consistent slope between level and 1 per cent.

6.1.2. The ambient temperature shall be between 0°C and 45°C.

6.1.3. The horizontal visibility range shall allow the target to be observed throughout the test.

6.1.4. The tests shall be performed when there is no wind liable to affect the results.

6.1.5. At the request of the manufacturer and with the agreement of the Technical Service tests may be conducted under deviating test conditions (suboptimal conditions, e.g. on a not dry surface; below the specified minimum ambient temperature; against a non-articulated pedestrian target), whilst the performance requirements are still to be met.

6.2. Vehicle Conditions

6.2.1. Test mass

The vehicle shall be tested:

(a) At the maximum mass;

(b) If this is deemed justified (e.g. if lower performance is expected when the sensors may miss the target due to low mass conditions), the technical service may test at the mass in running order with an additional mass of maximum 125 kg where this additional mass includes the measuring equipment and a possible second person who is responsible for noting the results in order to demonstrate compliance with the requirements referring to the mass in running order.

The load distribution shall be according to the manufacturer's recommendation and be annexed to the test report. No alteration shall be made once the test procedure has begun.

During the series of test runs, the fuel level may decrease but shall never fall below 50 per cent.

6.2.2. Pre-Test Conditioning

6.2.2.1. If requested by the vehicle manufacturer:

(a) The vehicle can be driven a maximum of 100 km on a mixture of urban and rural roads with other traffic and roadside furniture to initialise the sensor system.

(b) The vehicle can undergo a sequence of brake activations in order to ensure the service brake system is bedded in prior to the test.

(c) The average temperature of the service brakes on the hottest axle of the vehicle, measured inside the brake linings or on the braking path of the disc or drum, is below 100°C prior to each test run.

6.2.2.2. Details of the pre-test condition strategy requested by the vehicle manufacturer shall be identified and recorded in the vehicle type approval documentation.

6.2.3. The mounted tyres shall be identified and recorded in the vehicle type approval documentation.

6.2.4. The vehicle may be fitted with protective equipment that does not affect the results of the tests.

6.3. Test Targets

6.3.1. The target used for the pedestrian detection tests shall be a child "articulated soft target" and be representative of the human attributes applicable to the sensor system of the EMIS under test according to ISO 19206-2:2018.

6.3.2. The targets used for the bicycle detection tests shall be a "soft target" and be representative of the bicycle with adult cyclist attributes applicable to the sensor system of the EMIS under test according to ISO 19206-4:2020."

6.4. [reserved]

6.5. [reserved]

6.6. [reserved]

6.7. Motion inhibit test

The test shall demonstrate that it is only possible to accelerate the subject vehicle from standstill with two deliberate actions, provided a vulnerable road user is present in the region as specified in paragraph 5.2. 5..

The test shall be executed with

(a) A stationary pedestrian dummy;

(b) A stationary bicycle dummy;

(c) A moving pedestrian dummy;

(d) A moving bicycle dummy.

The test is passed when it is confirmed that the requirements from paragraph 5.2.5. (motion inhibit and collision warning) are met by the subject vehicle.

6.8. Failure Detection Test

6.8.1. Simulate an electrical failure, for example, by disconnecting the power source to any EMIS component or disconnecting any electrical connection between EMIS components. When simulating an EMIS failure, the electrical connections for the driver warning signal of paragraph 5.4.4. shall not be disconnected.

6.8.2. The failure warning signal mentioned in paragraph 5.4.4. above shall be activated and remain activated not later than 10 s after the vehicle has been driven at a speed greater than 10 km/h and be reactivated immediately after a subsequent ignition "off" ignition "on" cycle with the vehicle stationary as long as the simulated failure exists.

Annex 1 [reserved]

Annex 2 [reserved]

Annex 3

Special requirements to be applied to the safety aspects of electronic control systems

1. General

This annex defines the special requirements for documentation, fault strategy and verification with respect to the safety aspects of Complex Electronic Vehicle Control Systems (paragraph 2.4. below) as far as this Regulation is concerned.

This annex shall also apply to safety related functions identified in this Regulation which are controlled by electronic system(s) (paragraph 2.3.) as far as this Regulation is concerned.

This annex does not specify the performance criteria for "The System" but covers the methodology applied to the design process and the information which must be disclosed to the Technical Service, for type approval purposes.

This information shall show that "The System" respects, under non-fault and fault conditions, all the appropriate performance requirements specified elsewhere in this Regulation and that it is designed to operate in such a way that it does not induce safety critical risks.

2. Definitions

For the purposes of this annex,

2.1. "*The System*" means an electronic control system or complex electronic control system that provides or forms part of the control transmission of a function to which this Regulation applies. This also includes any other system covered in the scope of this Regulation, as well as transmission links to or from other systems that are outside the scope of this Regulation, that acts on a function to which this Regulation applies."

2.2. "*Safety Concept*" is a description of the measures designed into the system, for example within the electronic units, so as to address system integrity and thereby ensure safe operation under fault and non-fault conditions, including in the event of an electrical failure. The possibility of a fall-back to partial operation or even to a back-up system for vital vehicle functions may be a part of the safety concept.

2.3. "*Electronic Control System*" means a combination of units, designed to co-operate in the production of the stated vehicle control function by electronic data processing. Such systems, often controlled by software, are built from discrete functional components such as sensors, electronic control units and actuators and connected by transmission links. They may include mechanical, electro-pneumatic or electro-hydraulic elements.

2.4. "*Complex Electronic Vehicle Control Systems*" are those electronic control systems in which a function controlled by an electronic system or the driver may be over-ridden by a higher-level electronic control system/function. A

function which is over-ridden becomes part of the complex system, as well as any overriding system/function within the scope of this Regulation. The transmission links to and from overriding systems/function outside of the scope of this Regulation shall also be included.

2.5. "*Higher-Level Electronic Control*" systems/functions are those which employ additional processing and/or sensing provisions to modify vehicle behaviour by commanding variations in the function(s) of the vehicle control system. This allows complex systems to automatically change their objectives with a priority which depends on the sensed circumstances.

2.6. "*Units*" are the smallest divisions of system components which will be considered in this annex, since these combinations of components will be treated as single entities for purposes of identification, analysis or replacement.

2.7. "*Transmission links*" are the means used for inter-connecting distributed units for the purpose of conveying signals, operating data or an energy supply. This equipment is generally electrical but may, in some part, be mechanical, pneumatic or hydraulic.

2.8. "*Range of control*" refers to an output variable and defines the range over which the system is likely to exercise control.

2.9. "*Boundary of functional operation*" defines the boundaries of the external physical limits within which the system is able to maintain control.

2.10. "*Safety Related Function*" means a function of "The System" that is capable of changing the dynamic behaviour of the vehicle. "The System" may be capable of performing more than one safety related function.

3. Documentation

3.1. Requirements

The manufacturer shall provide a documentation package which gives access to the basic design of "The System" and the means by which it is linked to other vehicle systems or by which it directly controls output variables. The function(s) of "The System" and the safety concept, as laid down by the manufacturer, shall be explained. Documentation shall be brief, yet provide evidence that the design and development has had the benefit of expertise from all the system fields which are involved. For periodic technical inspections, the documentation shall describe how the current operational status of "The System" can be checked.

The Technical Service shall assess the documentation package to show that "The System":

(a) Is designed to operate, under non-fault and fault conditions, in such a way that it does not induce safety critical risks;

(b) Respects, under non-fault and fault conditions, all the appropriate performance requirements specified elsewhere in this Regulation; and,

(c) Was developed according to the development process/method declared by the manufacturer.

3.1.1. Documentation shall be made available in two parts:

(a) The formal documentation package for the approval, containing the material listed in paragraph 3. (with the exception of that of paragraph 3.4.4.) which shall be supplied to the Technical Service at the time of submission of the type approval application. This documentation package shall be used by the Technical Service as the basic reference for the verification process set out in paragraph 4. of this annex. The Technical Service shall ensure that this documentation

package remains available for a period determined in agreement with the Approval Authority. This period shall be at least 10 years counted from the time when production of the vehicle is definitely discontinued.

(b) Additional material and analysis data of paragraph 3.4.4. which shall be retained by the manufacturer, but made open for inspection at the time of type approval. The manufacturer shall ensure that this material and analysis data remains available for a period of 10 years counted from the time when production of the vehicle is definitely discontinued.

3.2. Description of the functions of "The System"

A description shall be provided which gives a simple explanation of all the control functions of "The System" and the methods employed to achieve the objectives, including a statement of the mechanism(s) by which control is exercised.

Any described function that can be over-ridden shall be identified and a further description of the changed rationale of the function's operation provided.

3.2.1. A list of all input and sensed variables shall be provided and the working range of these defined.

3.2.2. A list of all output variables which are controlled by "The System" shall be provided and an indication given, in each case, of whether the control is direct or via another vehicle system. The range of control (paragraph 2.8.) exercised on each such variable shall be defined.

3.2.3. Limits defining the boundaries of functional operation (paragraph 2.9.) shall be stated where appropriate to system performance.

3.3. System layout and schematics

3.3.1. Inventory of components.

A list shall be provided, collating all the units of "The System" and mentioning the other vehicle systems which are needed to achieve the control function in question.

An outline schematic showing these units in combination, shall be provided with both the equipment distribution and the interconnections made clear.

3.3.2. Functions of the units

The function of each unit of "The System" shall be outlined and the signals linking it with other units or with other vehicle systems shall be shown. This may be provided by a labelled block diagram or other schematic, or by a description aided by such a diagram.

3.3.3. Interconnections

Interconnections within "The System" shall be shown by a circuit diagram for the electric transmission links, by a piping diagram for pneumatic or hydraulic transmission equipment and by a simplified diagrammatic layout for mechanical linkages. The transmission links both to and from other systems shall also be shown.

3.3.4. Signal flow, operating data and priorities

There shall be a clear correspondence between these transmission links and the signals and/or operating data carried between units. Priorities of signals and/or operating data on multiplexed data paths shall be stated wherever priority may be an issue affecting performance or safety as far as this Regulation is concerned.

3.3.5. Identification of units

Each unit shall be clearly and unambiguously identifiable (e.g. by marking for hardware and marking or software output for software content) to provide corresponding hardware and documentation association.

Where functions are combined within a single unit or indeed within a single computer, but shown in multiple blocks in the block diagram for clarity and ease of explanation, only a single hardware identification marking shall be used. The manufacturer shall, by the use of this identification, affirm that the equipment supplied conforms to the corresponding document.

3.3.5.1. The identification defines the hardware and software version and, where the latter changes such as to alter the function of the unit as far as this Regulation is concerned, this identification shall also be changed.

3.4. Safety concept of the manufacturer

3.4.1. The Manufacturer shall provide a statement which affirms that the strategy chosen to achieve "The System" objectives will not, under non-fault conditions, prejudice the safe operation of the vehicle.

3.4.2. In respect of software employed in "The System", the outline architecture shall be explained and the design methods and tools used shall be identified. The Manufacturer shall show evidence of the means by which they determined the realisation of the system logic, during the design and development process.

3.4.3. The Manufacturer shall provide the Technical Service with an explanation of the design provisions built into "The System" so as to generate safe operation under fault conditions. Possible design provisions for failure in "The System" are for example:

(a) Fall-back to operation using a partial system.

(b) Change-over to a separate back-up system.

(c) Removal of the high level function.

In case of a failure, the driver shall be warned for example by warning signal or message display. When the system is not deactivated by the driver, e.g. by turning the ignition (run) switch to "off", or by switching off that particular function if a special switch is provided for that purpose, the warning shall be present as long as the fault condition persists.

3.4.3.1. If the chosen provision selects a partial performance mode of operation under certain fault conditions, then these conditions shall be stated and the resulting limits of effectiveness defined.

3.4.3.2. If the chosen provision selects a second (back-up) means to realise the vehicle control system objective, the principles of the change-over mechanism, the logic and level of redundancy and any built in back-up checking features shall be explained and the resulting limits of back-up effectiveness defined.

3.4.3.3. If the chosen provision selects the removal of the higher level function, all the corresponding output control signals associated with this function shall be inhibited, and in such a manner as to limit the transition disturbance.

3.4.4. The documentation shall be supported, by an analysis which shows, in overall terms, how the system will behave on the occurrence of any individual hazard or fault which will have a bearing on vehicle control performance or safety.

The chosen analytical approach(es) shall be established and maintained by the Manufacturer and shall be made open for inspection by the Technical Service at the time of the type approval.

The Technical Service shall perform an assessment of the application of the analytical approach(es). The audit shall include:

(a) Inspection of the safety approach at the concept (vehicle) level with confirmation that it includes consideration of interactions with other

vehicle systems. This approach shall be based on a Hazard / Risk analysis appropriate to system safety.

(b) Inspection of the safety approach at the system level. This approach shall be based on a Failure Mode and Effect Analysis (FMEA), a Fault Tree Analysis (FTA) or any similar process appropriate to system safety.

(c) Inspection of the validation plans and results. This validation shall use, for example, Hardware in the Loop (HIL) testing, vehicle on–road operational testing, or any means appropriate for validation.

The assessment shall consist of checks of hazards and faults chosen by the Technical Service to establish that the manufacturer's explanation of the safety concept is understandable, logical and that the validation plans are suitable and have been completed.

The Technical Service may perform or may require to perform tests as specified in paragraph 4. to verify the safety concept.

3.4.4.1. This documentation shall itemize the parameters being monitored and shall set out, for each fault condition of the type defined in paragraph 3.4.4. of this annex, the warning signal to be given to the driver and/or to service/technical inspection personnel.

3.4.4.2. This documentation shall describe the measures in place to ensure the "The System" does not prejudice the safe operation of the vehicle when the performance of "The System" is affected by environmental conditions e.g. climatic, temperature, dust ingress, water ingress, ice packing.

4. Verification and test

4.1. The functional operation of "The System", as laid out in the documents required in paragraph 3., shall be tested as follows:

4.1.1. Verification of the function of "The System"

The Technical Service shall verify "The System" under non-fault conditions by testing a number of selected functions from those declared by the manufacturer in paragraph 3.2. above.

For complex electronic systems, these tests shall include scenarios whereby a declared function is overridden.

4.1.2. Verification of the safety concept of paragraph 3.4.

The reaction of "The System" shall be checked under the influence of a failure in any individual unit by applying corresponding output signals to electrical units or mechanical elements in order to simulate the effects of internal faults within the unit. The Technical Service shall conduct this check for at least one individual unit, but shall not check the reaction of "The System" to multiple simultaneous failures of individual units.

The Technical Service shall verify that these tests include aspects that may have an impact on vehicle controllability and user information (Human Machine Interface aspects).

4.1.2.1. The verification results shall correspond with the documented summary of the failure analysis, to a level of overall effect such that the safety concept and execution are confirmed as being adequate.

5. Reporting by Technical Service

Reporting of the assessment by the Technical Service shall be performed in such a manner that allows traceability, e.g. versions of documents inspected are coded and listed in the records of the Technical Service.

An example of a possible layout for the assessment form from the Technical Service to the Type Approval Authority is given in Appendix 1 to this Annex.

Annex 3 - Appendix 1

Model assessment form for electronic systems

Test report No: .....

1. Identification

1.1. Vehicle make: .....

1.2. Type: .....

1.3. Means of identification of type if marked on the vehicle: .....

1.4. Location of that marking:.....

1.5. Manufacturer's name and address:.....

1.6. If applicable, name and address of manufacturer's representative:.....

1.7. Manufacturer's formal documentation package:

Documentation reference No: .....
Date of original issue: .....
Date of latest update: .....

2. Test vehicle(s)/system(s) description

2.1. General description: .....

2.2. Description of all the control functions of "The System", and methods of operation: ..

2.3. Description of the components and diagrams of the interconnections within "The System": .....

3. Manufacturer's safety concept

3.1. Description of signal flow and operating data and their priorities: .....

3.2. Manufacturer's declaration:
The manufacturer(s) ..... affirm(s) that the strategy chosen to achieve "The System", objectives will not, under non-fault conditions, prejudice the safe operation of the vehicle.

3.3. Software outline architecture and the design methods and tools used: .....

3.4. Explanation of design provisions built into "The System" under fault conditions: .....

3.5. Documented analyses of the behaviour of "The System" under individual hazard or fault conditions: .....

3.6. Description of the measures in place for environmental conditions: .....

3.7. Provisions for the periodic technical inspection of "The System": .....

3.8. Results of "The System" verification test, as per para. 4.1.1. of Annex 3 to UN Regulation No. XXX:.....

3.9. Results of safety concept verification test, as per para. 4.1.2. of Annex 3 to UN Regulation No. XXX:.....

3.10. Date of test: .....

3.11. This test has been carried out and the results reported in accordance with ….. to UN Regulation No. XXX

Technical Service[1] carrying out the test
Signed: ..... Date: .....

3.12. Comments: .....

[1] To be signed by different persons even when the Technical Service and Type Approval Authority are the same or alternatively, a separate Type Approval Authority authorization is issued with the report.

II. Justification

1. t.b.d.