Add a new paragraph 6.7., to read:

6.7. Computer simulation of dynamic tests

6.7.1. In addition to a minimal set of warning and activation physical tests, as prescribed in annex 4 paragraph 2.3., at the discretion of the manufacturer, an equivalent method based on computer simulation may be choosen for the tests specified in paragraphs 6.4. to 6.6.

6.7.2. The computer simulation, via dynamic calculations, of the warning and activation tests shall be performed in accordance with annex 4.

6.7.3. The basic principle is that the equivalent approval test method must be carried out in such a way that it represents the warning and activation physical tests specified in paragraphs 6.4. to 6.6. If the equivalent approval test method chosen by the manufacturer cannot take account of some special parameters or construction of the vehicle, the physical tests may be required by the technical service to undergo the warning and activation tests.

6.7.4. Simulation tools and mathematical models for evaluation of the warning and activation tests may be used in accordance with Schedule 8 of Revision 3 of the 1958 Agreement. Manufacturers shall demonstrate the scope of the simulation tool, its validity for the scenario concerned as well as the validation performed for the simulation tool chain (correlation of the outcome with physical tests) in accordance with annex 4.

6.7.5. In order to validate the simulation method proposed to be used by the manufacturer, the technical service shall ensure to have appropriate simulation skills to provide the minimum representativeness level to be reached and an objective protocol to cote it to the manufacturer.

6.7.6. In case the computer simulation of dynamic tests is choosen by the manufacturer, a separated report shall be provided by the technical service including at least the additional data information specified in annex 4 paragraph 1.4.

Add a new Annex 4, to read:

Annex 4 – Computer simulation of dynamic tests as an equivalent approval method

1. Validation of the simulation method

In order to guarantee that the simulation method used by the manufacturer is able to provide representative results acceptable for approval process, this simulation method shall be first evaluated and validated by the technical service.

1.1. Mathematical model

1.1.1. The mathematical model shall be supplied by the manufacturer. It shall reflect the complexity of the architecture of the vehicle, system and components to be tested in relation to the requirements of the current regulation and its boundary conditions.

1.1.2. The model shall be capable of describing the real physical behavior of the braking activation process.

1.1.3. The mathematical model shall be constructed, and assumptions prescribed, in such a way that the calculation gives conservative solution, in which the result is independent of the incremental time step.

1.1.4. In addition to the parameters listed in paragraph 1.4. of the current annex, the following elements have to be defined in the mathematical model :

- Vehicle dynamic model ;
- Sensor model ;
- Model ADAS order form ;
- Environment model ;
- Scenario model ;
- Target model for pedestrians, cyclists and cars ;

1.2. Physical tests

1.2.1. The technical service shall require tests to be carried out on the system to prove the validity of the mathematical model and to verify the assumptions made in the model, by using specific testing instrumentation if needed.

1.2.2. The number of scenarios to be tested shall be defined with the technical service in order to cover the validity area requested by the manufacturer.

1.2.3. The physical tests used for building a physical reference for the numerical model validation shall be repetable.

1.2.3.1. At least 10 repetitions of worst cases scenarios shall be performed and results of the stop relative distance from target or target impact velocity shall be inside a defined interval from the mediane value. This interval is defined by the technical service.

1.3. Mathematical model validation process

1.3.1. The mathematical model shall be validated in comparison with the physical tests performed under paragraph 1.2. and comparability of the test results shall be proven.

1.3.1.1. Two successive comparisons shall be provided for each test parameter sets :

- An initial evaluation in "raw coding" without any modfication after the tests results and ;
- An « optimized » evaluation by adjusting the numerical parameters in order to improve the representativeness with respect to the physical test setups (target detection, activation of ADAS function, position of targets, adherence, modeling of the real behavior of the target, the reality of the field, the real realization of the protocol, ...).

1.3.1.2. In order to guarantee the conditions of comparison, the output data of the tests carried out shall include a video of the test and environmental data (temperature, sun orientation, etc.).

1.3.1.3. A minimum representativeness level defined by the technical service shall be reached based on the calculation of a weighted average of the simulation/test deviations regarding at least the following variables if applicable :

- subject vehicle and target speeds ;
- subject vehicle and target longitudinal accelerations ;
- subject vehicle and target lateral deviation ;
- subject vehicle relative distance with the target ;
- subject vehicle relative impact speed with the target ;
- subject vehicle relative stop distance with the target ;
- subject vehicle system initiation time ;
- subject vehicle collision warning time ;

1.3.1.4. An objective protocol for the representativeness evaluation of the method used by the manufacturer shall be provided by the technical service in order to cote the representativeness level of the method.

1.3.2. Any change made to the mathematical model, vehicle / system architetcure or to the software likely to invalidate this validation shall be brought to the attention of the approval authority which may require that a new validation process is conducted.

1.4. Additional data and information

For this application, the following information shall be supplied to the approval authority and technical service in addition to the data, and drawings listed in paragraph 3.2. of this Regulation.

1.4.1. A description of the applied simulation and calculation method which has been used with identification of model, the analysis software, including at least, its producer, its commercial name, the version and contact details of the developer.

1.4.2. A description of the input parameters encoding the models used including at least systems functionalities characterization, mechanical hypothesis, values for defined masses, centre of gravity, moments of inertia and boundary conditions.

1.4.3. A definition of the validity area based on vehicle parameters as mass distribution, speed ranges, breaking order range, etc … used in the application of paragraph 1.2.2. of the current annex.

1.4.4. Each step of the calculcation shall be detailed by the manufacturer : pre-processing, processing and post-processing including a justification of the normal termination of the simulation.

1.4.5. The final level of representativeness reached by the computer simulation proivided by the manufacturer with the detailed results of the objective protocol for cotation requested by the technical service.

2. Simulation results for approval process

2.1. The manufacturer may provide simulation results to meet the requirements specified in paragraphs 6.4. to 6.6. of this Regulation only if the method used to obtain the results have already been evaluated and validated in application of pargraph 1. of the current annex.

2.2. All simulation results provided by the manufacturer in application of the approval following paragraph 4. Of the current regulation shall reffered to the method previously evaluated and validated in application of pargraph 1. of the current annex.

2.3. In addition to the simulation results, a minimum of 5 tests per scenario 5.2.1. (car to car), 5.2.2. (car to pedestrian) and 5.2.3. (car to bicycle) defined by the technical service has to be perfomed in order to confirm the subject vehicle perfomance on relevant test parameters sets.

2.4. Additional data and information

For this application, the following information shall be supplied to the technical service in addition to the data, and drawings listed in paragraph 3.2. of this Regulation.

2.4.1. A description of the applied simulation and calculation method which has been used with identification of model, the analysis software, including at least, its producer, its commercial name, the version and contact details of the developer.

2.4.2. A description of the input parameters encoding the models used including at least systems functionalities characterization, mechanical hypothesis, values for defined masses, centre of gravity, moments of inertia and boundary conditions.

2.4.3. A reference to the validated simulation method used in application of pargraph 1. of the current annex.

2.4.4. Each step of the calculcation shall be detailed by the manufacturer : pre-processing, processing and post-processing including a justification of the normal termination of the simulation.