

RESPONSES RECEIVED ON DRAFT REPORT: 'ENGINE FAILURE DURING INITIAL CLIMB, BOEING 747-412BCF, MEERSSEN'

The fourth and fifth columns provide the literal text of the responses of the parties. The last column contains an explanation from the Dutch Safety Board of the way the responses were processed.

No.	Organisation	Section	Text to be corrected (first ... last word)	Argumentation for response	Adopted?	Dutch Safety Board's response
1	Boeing	Summary	On Saturday 20 February 2021, a Boeing 747-400 encountered an a <u>contained</u> engine failure during the initial climb out from Runway 21 at Maastricht Aachen Airport in the Netherlands.	To indicate to the reader the engine failure was contained.	Yes	The text has been modified.
2	Boeing	Summary	The investigation into this serious <u>contained engine failure event</u> incident revealed that the turbine of engine number one of the aeroplane had failed.	To indicate to the reader the engine failure was contained.	No	That the engine failure was contained, has already been mentioned earlier in the summary, based on the previous comment.
3	Boeing	Summary	An operator is not required to implement service bulletins; however, he must be able to demonstrate his reasoning to implement or not implement service bulletins. In this way, the operator and its maintenance organisation can ensure the safety of flight. The operator, who had been using the aeroplane in its fleet for three months at the time of the incident, was not able to present the decision for not implementing service bulletin with number 72-462.	Boeing believes the draft report should reference the regulation that requires the event operator document its assessment of service bulletins that are not considered an urgent safety issue, to demonstrate why a service bulletin was or was not incorporated. Boeing suggests removing or appropriately modifying this section of the report, if a regulation is not referenced.	Yes	The text has been removed, as a regulation is not referenced.
4	AAIB	Summary	'The operator, who had been using the aeroplane in its fleet for three months at the time of the incident, was not able to present the decision for not implementing service bulletin with number 72-462.'	The aircraft (engine) was under the responsibility of a different owner/operator at the time SB 72-462 was published. Therefore, the initial decision whether to embody/not embody this SB would have been taken (and should have been recorded) by that organisation - not the current operator. The report does not touch upon the responsibility of the lessor in regard to embodiment of the SBs/ADs. See additional comments below on this subject.	Partly	The text has been modified. The responsibility of the lessor has not been investigated in depth.

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5	Boeing	Summary	As is the case with this engine failure, the convergence of air traffic over areas surrounding airports increases the risk of occurrences. The fact that these areas of convergence run over the villages of Meerssen, Geverik and Beek shows that its residents are involuntarily exposed to a risk of departing engine debris, that is <u>likely</u> higher than the risk in other residential areas surrounding the airport. The engine failure showed that the hazard of departing engine parts is real, resulting in injured people and damaged property. The <u>local</u> risk of this hazard has not been quantified, therefore a <u>local</u> risk assessment and acceptance by the government have not been accomplished.	<p>EASA states the CM covers parts that become detached from the aeroplane with no or low initial relative speed to the aeroplane, and as such, "high energy rotating parts departing from the engine" are beyond the scope. High energy rotating parts are generally considered within the industry to be those which present a risk of uncontained engine failure such as disks, but not blades. Certification standards ensure that blade failures are contained by the engine case structure. The reason for excluding high energy rotating parts from the assessment, is that failure of the parts can create hazards to the airplane beyond that of a typical PDA, which are considered in the design and certification of the airplane per AMC 20-128A. Therefore, special considerations beyond those outlined in Section 3.2 of the EASA CM may be needed to assess the potential for damage to the airplane itself. As the engine is designed to contain blade failures, as was the case in this subject event, the initial radial release energy is absorbed by the engine case structure. Blades that then travel axially through the engine and exit the engine exhaust would not present the same hazard to the airplane as high energy rotating parts.</p> <p>It is further noted that the assumptions outlined in the EASA CM 3.3, hazards to People on the Ground, do not depend on the initial velocity of the part relative the airplane. The analysis conclusions presented in the EASA CM relative to People on the Ground, and the rationale presented for concluding no unsafe condition has been identified for people on the ground, is considered applicable to turbine blades exiting the engine exhaust. Therefore, if required, it would be more appropriate to consider a location specific risk assessment, that potentially also takes into consideration the risk for property damage, which is not typically considered by the aviation industry as a hazard and is not included in EASA CM No.: CM-21.A-A-001</p>	Partly	<p>The word 'local' has not been added because the text has been modified and is now general in nature and does not only relate to the situation near Maastricht Aachen Airport.</p> <p>The focus in this report is on the hazard to people on the ground and not on the risk for property damage.</p>
6	Boeing	Summary	Residents around the airport are exposed to different types of risk, such as departing engine debris, parts departing the aircraft and an accident with an aircraft. However, there has not been a method of integral risk assessment of these <u>local</u> risks. According to the Dutch Safety Board, only in this way an informed decision about the acceptance of this <u>local</u> risk can be made.	<p>EASA states the CM covers parts that become detached from the aeroplane with no or low initial relative speed to the aeroplane, and as such, "high energy rotating parts departing from the engine" are beyond the scope. High energy rotating parts are generally considered within the industry to be those which present a risk of uncontained engine failure such as disks, but not blades. Certification standards ensure that blade failures are contained by the engine case structure. The reason for excluding high energy rotating parts from the assessment, is that failure of the parts can create hazards to the airplane beyond that of a typical PDA, which are considered in the design and certification of the airplane per AMC 20-128A. Therefore, special considerations beyond those outlined in Section 3.2 of the EASA CM may be needed to assess the potential for damage to the airplane itself. As the engine is designed to contain blade failures, as was the case in this subject event, the initial radial release energy is absorbed by the engine case structure. Blades that then travel axially through the engine and exit the engine exhaust would not present the same hazard to the airplane as high energy rotating parts.</p> <p>It is further noted that the assumptions outlined in the EASA CM 3.3, hazards to People on the Ground, do not depend on the initial velocity of the part relative the airplane. The analysis conclusions presented in the EASA CM relative to People on the Ground, and the rationale presented for concluding no unsafe condition has been identified for people on the ground, is considered applicable to turbine blades exiting the engine exhaust. Therefore, if required, it would be more appropriate to consider a location specific risk assessment, that potentially also takes into consideration the risk for property damage, which is not typically considered by the aviation industry as a hazard and is not included in EASA CM No.: CM-21.A-A-001.</p>	Partly	<p>The word 'local' has been added.</p> <p>The focus in this report is on the hazard to people on the ground and not on the risk for property damage. Location-specific risk contours are used to indicate the risk of death as a result of an accident with an aeroplane in the immediate vicinity of a runway. When the risks of departing aircraft parts and engine debris are included in those contours, they can be used to make a decision about the acceptance of the local risk for people on the ground.</p>

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7	Boeing	Recommendations	Make and keep the record keeping of the (non-) implementation of service bulletins for leased engines of your fleet of commercial air transport aeroplanes complete and accessible.	Boeing believes the draft report should reference the regulation that requires the event operator document its assessment of service bulletins that are not considered an urgent safety issue, to demonstrate why a service bulletin was or was not incorporated. Boeing suggests removing or appropriately modifying this recommendation, if a regulation is not referenced.	No	This recommendation is not based on regulations, but on a finding of the Dutch Safety Board.
8	Pratt & Whitney	Recommendations	"Advise all operators..."	<p>Comment: Pratt & Whitney believes it has met the intent of this recommendation via the following: Pratt & Whitney Engineering discussed the importance of incorporating the improved HPT cooling configuration at both the January and April 2022 Customer Council Calls (see Attachment 2 for slides that were presented). The subject was also discussed at the November 2022 PW4000 World Operators Conference. We believe this to constitute closing action for this recommendation.</p> <p>See also Section 5, Recommendations, page 37, lines 18-20. Same comment.</p>	Yes	The draft recommendation to Pratt & Whitney has been removed, as according to the Board the measures taken by Pratt & Whitney, to inform users about the importance of incorporating the improved HPT cooling configuration, are sufficient.
9	MAA	2.2	Two persons on the ground suffered minor injuries: one person was struck by a falling piece of debris and one person received minor burns while picking up a piece that was still hot. Both persons received medical treatment at the scene, they were released from medical attention shortly after.	<p>This may not do justice to the injuries and aftermath that one of the victims has had. I would therefore omit the first minor. According to the daughter of the victim, they were indeed discharged from medical treatment, but the lady went to the hospital that evening and underwent surgery there.</p> <p>Original response in Dutch: Dit doet wellicht geen recht aan de verwondingen en nasleep die 1 van de slachtoffers heeft gehad. Ik zou de eerste minor daarom weglaten. Ze zijn volgens de dochter van het slachtoffer idd ontslagen van medische behandeling, maar mevrouw is die avond dus naar het ziekenhuis gegaan en geopereerd.</p>	Yes	The text has been modified.
10	Boeing	2.3	The number 1 engine <u>encountered a contained engine failure and</u> sustained internal damage of among others the high pressure turbine and low pressure turbine. For a further description of the damage, see Section 2.10.1. There was no damage to other parts of the aeroplane.	To indicate to the reader the engine failure was contained.	Yes	The text has been modified.
11	DGLM	2.6		<p>The Dutch Safety Board investigation does not report how the aeroplane is used operationally by the airline, nor does it include the (publicly known) positive effects of occasionally applying a lower selected engine power at takeoff, resulting in longer engine life .</p> <p><i>Original response in Dutch: Het OVV-onderzoek meldt niet hoe het vliegtuig operationeel wordt gebruikt door de luchtvaartmaatschappij en betreft daarbij ook niet de (algemeen bekende) positieve effecten om bij gelegenheid een lager geselecteerd motorvermogen bij de start toe te passen, wat resulteert in een langere levensduur van de motor.</i></p>	No	The relation between the moment of failure of the affected engine and the operational use of the aeroplane to determine a different moment of failure in time, was beyond the scope of the investigation.
12	AAIB	2.11.1	'The operator had therefore been using the aeroplane for three months on the day the occurrence took place.'	While the report indicates that the operator had only been operating the aircraft (engine) for a short time, it does not describe what actions the operator took (or was expected to take) to satisfy itself of the SB/AD compliance status of the aircraft/engine. This additional information might assist the reader. Equally the report does not include the responsibility of the lessor in regards to SB implementation and the associated record keeping.	No	<p>The question asked to the operator (at the time of the incident) whether he was aware of the non-implemented SB 72-462 for engine 727305 has remained unanswered. The same applies to the question to the operator whether he was in possession of documentation, which he obtained from the previous operator, showing that SB 72-462 was not carried out.</p> <p>The responsibility of the lessor has not been investigated in depth.</p>

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13	AAIB	2.11.3	'In relation to SB 72-462, the United States Federal Aviation Administration (FAA) stated that "this service bulletin was introduced in 1993 to address the ceramic deterioration on the HPT second stage duct segment by adding cooling airflow and enhanced sealing to the HPT. The FAA did not issue an airworthiness directive for this issue, because the ceramic deterioration of the HPT second stage duct segment was not seen as a safety concern."	<p>The report places considerable focus on the decision not to implement SB 72-462 but, other than this brief mention, does not further explore the FAA's assessment that the deterioration of the HPT second stage duct segment was not a safety concern.</p> <p>Perhaps the report should explore whether that assessment was correct and whether SB 72-462 should have been made mandatory.</p>	No	<p>The Dutch Safety Board did not assess the FAA's process to determine if the deterioration of the HPT second stage duct segment was a safety concern, as this was beyond the scope in the investigation. The investigation showed that the ceramic deterioration of the HPT second stage duct segment was not a safety concern for the aircraft.</p> <p>With regard to the decision not to implement SB 72-462, the questions in line 12 (in this column) have been asked. As no response was received, no further investigation was carried out in addition to requesting maintenance information from previous CAMOs that had already taken place.</p>
14	Pratt & Whitney	2.12.2	"All those engine failures were contained (see Section 2.12.4) and injuries to third parties or damage to property did not occur."	<p>Recommend: "No injuries to third parties or damage to property occurred during any of those prior events, though one event was categorized as nacelle uncontained (see section 2.12.4)."</p> <p>Rationale: One event classified as nacelle uncontained (engine 717659, on 23 October 2011). No damage to third parties or injuries. Reference NTSB Incident Investigation ENG12IA003.</p>	Yes	The text has been modified.
15	Boeing	2.12.2	As mentioned before, <u>the engine failure was contained</u> and the event engine was equipped with the latest type of OTD segments.	To indicate to the reader the event failure engine failure was contained, as were all of the previous events noted in this section of the report.	No	In the last sentence of this section, the emphasis was put on the type of OTD segments that were installed in the affected engine. It has already been mentioned in the report, that the engine failure was contained.
16	DGLM			<p>The Dutch Safety Board investigation does not mention the investigation by the Italian Civil Aviation Investigation Authorities (ANSV) of a similar serious incident at the takeoff of a Boeing 787 passenger aircraft from Rome Airport in 2019 with associated recommendations, as well as the response to these recommendations from EASA. These data were and are available to the Dutch Safety Board and are highly relevant.</p> <p><i>Original response in Dutch: Het OVV-onderzoek maakt geen melding van het onderzoek van de Italiaanse onderzoeksautoriteiten voor de burgerluchtvaart (ANSV) van een soortgelijk ernstig incident bij de start van een Boeing 787 passagiersvliegtuig van de luchthaven van Rome in 2019 met bijbehorende aanbevelingen, alsmede de reactie op deze aanbevelingen van EASA. Deze gegevens waren en zijn beschikbaar voor de OVV en zijn zeer relevant.</i></p>	Yes	The Dutch Safety Board was familiar with the report of the ANSV. It is now mentioned in the report of the Dutch Safety Board, which also addresses one recommendation to EASA, that is included in the ANSV report. This recommendation applies to the present investigation. In the analysis of the report, reference will be made to the ANSV investigation.
17	DGLM			<p>The Dutch Safety Board investigation does not address why EASA has not quantified the danger of falling engine parts for persons on the ground in the existing documentation, while this is an important basic data for any possible approach to the problem.</p> <p><i>Original response in Dutch: Het OVV-onderzoek adresseert niet waarom EASA het gevaar van vallende motoronderdelen niet heeft gekwantificeerd voor personen op de grond in de daarvoor bestaande documentatie, terwijl dat wel een belangrijk basisgegeven is voor een eventuele aanpak van het probleem.</i></p>	Partly	In EASA CM No.: CM-21.A-A-001 Issue 01 issued 29 November 2018, the likelihood of fatally injuring people on the ground due to a PDA (parts departing aircraft) event is conservatively estimated and also quantified. The conclusions in this CM apply to engine parts as well. However, the objective of the CM is to provide guidance only. The text in Section 3.2 has been amended for clarification.

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18	Boeing	2.12.4	In 2018, EASA issued a certification memorandum about parts detached from aeroplanes. ^{43,44} It is concluded in this document that in this type of events, given the current observed rates of loss of parts per flight hour, the risk of injuries to persons on the ground or damage to other aeroplanes does not constitute an unsafe condition. ⁴⁵ However, this certification memorandum does not apply to engine debris, considered as high energy rotating parts. In the present case, the engine debris was viewed as high energy rotating parts.	<p>EASA states the CM covers parts that become detached from the aeroplane with no or low initial relative speed to the aeroplane, and as such, "high energy rotating parts departing from the engine" are beyond the scope. High energy rotating parts are generally considered within the industry to be those which present a risk of uncontained engine failure such as disks, but not blades. Certification standards ensure that blade failures are contained by the engine case structure. The reason for excluding high energy rotating parts from the assessment, is that failure of the parts can create hazards to the airplane beyond that of a typical PDA, which are considered in the design and certification of the airplane per AMC 20-128A. Therefore, special considerations beyond those outlined in Section 3.2 of the EASA CM may be needed to assess the potential for damage to the airplane itself. As the engine is designed to contain blade failures, as was the case in this subject event, the initial radial release energy is absorbed by the engine case structure. Blades that then travel axially through the engine and exit the engine exhaust would not present the same hazard to the airplane as high energy rotating parts.</p> <p>It is further noted that the assumptions outlined in the EASA CM 3.3, hazards to People on the Ground, do not depend on the initial velocity of the part relative the airplane. The analysis conclusions presented in the EASA CM relative to People on the Ground, and the rationale presented for concluding no unsafe condition has been identified for people on the ground, is considered applicable to turbine blades exiting the engine exhaust.</p>	Partly	The last of the two proposed sentences to be removed has been removed. According to the Board, the first sentence is a correct representation of what is stated in the certification memorandum.
19	Pratt & Whitney	2.12.4	"However, this certification memorandum does not apply to engine debris, considered as high energy rotating parts. In the present case, the engine debris was viewed as high energy rotating parts."	<p>Recommend: removal of the last sentence.</p> <p>Rationale: There is currently no accepted standard industry definition of "high energy" or "low energy" with respect to uncontained engine events, so recommend omitting this statement. While there is no accepted industry definition, events that are contained like the subject incident, do not meet Pratt & Whitney's interpretation of the intent of a high energy classification which would be more akin to a disk/rotor fracture which is radially uncontained by the engine.</p>	Yes	The text has been modified.
20	EASA	2.12.4	However,...high energy rotating parts.	<p>Whilst it is correct that the referenced EASA Certification Memorandum suggests that this is applicable only to aircraft parts, an engine installed on an aircraft can also be considered being part of it.</p> <p>Compared to static airframe parts, released engine parts may be rotating and thus may leave the aircraft boundaries with a kinetic energy that is higher than that of a static aircraft part featuring the same mass. However, it is considered that for the same mass the kinetic energy at a certain distance from the aircraft boundaries is comparable with other airframe parts. Therefore, the conclusions in the mentioned CM could well apply for engine parts as well.</p>	Yes	Footnote 44 (footnote 45 in the current version of the report) has been modified.

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21	EASA	2.12.4	In the present case, ... high energy rotating parts they either remain ... or are ejected.	<p>It is not clear how the subject failure is classified with respect to its severity. Debris exiting the engine either from the front of the rear are normally considered low energy (with respect to its effects on the A/C only), i.e. it is not considered to cause a Hazardous situation.</p> <p>Lines 6-7 state that the failure was considered to involve release of high energy rotating parts.</p> <p>Lines 21-23 suggest that parts ejected from the engine exhaust are considered in terms of their severity to be comparable to parts contained within the engine casings.</p> <p>Regarding precautions against uncontained failures with release of high energy fragments of rotating parts at aircraft level, these concern cases where the fragments are exiting the engine in radial direction penetrating the engine casings and featuring at the boundaries of the engine casings sufficient energy to hazard other aircraft systems. This is not the case here in this failure scenario. Therefore, it is considered that with respect to aeroplane safety, the event investigated is not release of high energy rotating parts in the sense of the applicable certification specifications.</p>	Yes	The text has been modified.
22	AAIB	3.1	'Engines equipped with the additional cooling features and redesigned outer transition ducts, as prescribed by the SBs and ADs, do not show the above failure mode. Therefore, the measures appear to be effective to prevent this failure mode.'	<p>This statement is not supported by the evidence presented in the report. On Pg 32 Lines 5-6 you state: 'the present failure was the first time that the outer transition ducts failed that were of the redesigned type.' As this is the first failure of an engine with redesigned ducts, it is not possible to say with certainty that engines equipped with additional cooling features and redesigned outer transition ducts do not show this failure mode, only that to date, such engines have not exhibited this failure mode.</p> <p>Further, information provided by the engine manufacturer during the investigation indicated that (given certain conditions) it is still possible to liberate an OTD with both SB 72-488 and SB 72-462 incorporated, but these upgrades add significant margin and greatly minimize the probability of these events.</p>	Yes	The text has been modified.
23	Pratt & Whitney	3.1	"...first time the outer transition ducts failed that were of the redesigned type."	<p>Recommend: "...first known time the outer transition ducts failed that were of the redesigned type in the PW4000-94" engine family."</p> <p>Rationale: For clarity, P&W has history of redesigned outer transition ducts liberating in the PW4000-100", due to the significantly hotter temperatures in that engine. The OTD for the -94" and -100" are similar configurations. The FAA has issued an Airworthiness Directive to fully replace the outer transition ducts, regardless of design, at the next shop visit for that engine. In the lower temperature 94" configuration, it is true, there have been no redesigned OTD liberations reported to P&W, prior to the subject event.</p>	Yes	The text has been modified.
24	AAIB	3.1	'Scheduled maintenance was accomplished in 1999 and 2009 during which the engine was disassembled (see the timeline in Appendix F).'	<p>Please amend as follows: 'Scheduled maintenance was accomplished in 1999 and 2009 during which the engine was disassembled (see the timeline in Appendix F). During this time the aircraft and engine were under the responsibility of another owner/operator.'</p> <p>What was the role of the lessor (if any) in deciding what SBs to embody?</p>	Partly	<p>The text has been modified.</p> <p>The responsibility of the lessor has not been investigated in depth.</p>

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25	Boeing	3.1	The incorporation of a service bulletin is an operator's decision. A commercial air transport operator needs to be able to present the assessment of this decision, even if this occurred before the engine in question (in the present case) was not yet in use by the operator. The operator Longtail Aviation was not able to present the reasoning regarding the non-incorporation of SB 72-462. This implies that the operator was not aware of the implications of not implementing this service bulletin. Despite the fact that the content of the service bulletin was not considered an urgent safety issue, an operator and its maintenance organisation must be able to demonstrate why a service bulletin was or was not incorporated.	Boeing believes the draft report should reference the regulation that requires the event operator document its assessment of service bulletins that are not considered an urgent safety issue, to demonstrate why a service bulletin was or was not incorporated. Boeing suggests removing or appropriately modifying this section of the report, if a regulation is not referenced.	Yes	The text has been removed, as a regulation is not referenced.
26	AAIB	3.1	'The operator Longtail Aviation was not able to present the reasoning regarding the non-incorporation of SB 72-462. This implies that the operator was not aware of the implications of not implementing this service bulletin.'	<ol style="list-style-type: none"> 1. Please amend as follows: 'Despite not being responsible for decisions not to embody SB 72-462 at the shop visits in 1999 and 2009, the operator was not able to present the documented reasoning regarding the non-incorporation of SB 72-462.' 2. Also, I don't believe this statement is necessarily true: 'This implies that the operator was not aware of the implications of not implementing this service bulletin.' 3. Is there any evidence that if Longtail had embodied this SB in the short time it operated the engine, it would have prevented the failure? It seems likely that the damage to the OTDs would have been done already. 4. Consider including information about what information was available in the aircrafts/engines' technical records to assist the operator in making this determination. And please consider the role of the lessor in this process. 5. Consider adding information here on what actions the current operator took to satisfy itself on the SB/AD compliance status of the engine. 6. Please also consider adding information relating to when the next shop visit was due. No shop visits occurred during the short time the aircraft (engine) had been in the current operator's fleet. Had a shop visit been imminent, this may have provided the opportunity to review the applicable SB's and ADs and assess which were outstanding. 	Partly	<ol style="list-style-type: none"> 1. The text has been modified. 2. The text has been removed. 3. This has not been investigated by the Board. 4. The operator was in the possession of the respective service bulletin; this in combination with the experience concerning its engines makes it possible to determine the way the service bulletin is incorporated or not. This has not been incorporated in the report. The responsibility of the lessor has not been investigated in depth. 5. Regarding actions by the current operator to satisfy itself on the SB/AD compliance status of the engine, see the response in line 12. 6. It is unclear if the engine was due for removal in the near future. It is not necessarily the case that the LPT module would have been overhauled at that next visit either. It depends on a number of factors and hot section service intervals vary greatly by operations.
27	Boeing	3.1	The operator was not able to demonstrate the reasoning for not implementing Service Bulletin 72-462. This implies that the operator was not aware of the safety implications of this safety bulletin. It is important to emphasise that an operator must be able to demonstrate the reasoning to implement or not implement service bulletins. In this way, the operator and its maintenance organisation can ensure safe flight operations.	Boeing believes the draft report should reference the regulation that requires the event operator document its assessment of service bulletins that are not considered an urgent safety issue, to demonstrate why a service bulletin was or was not incorporated. Boeing suggests removing or appropriately modifying this section of the report, if a regulation is not referenced.	Yes	The text has been removed, as a regulation is not referenced.

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28	Boeing	3.2	Within aviation, the magnitude of the risk of departing engine debris has not been determined and no unsafe condition has been identified for people on the ground. therefore it is not managed.	<p>EASA states the CM covers parts that become detached from the aeroplane with no or low initial relative speed to the aeroplane, and as such, "high energy rotating parts departing from the engine" are beyond the scope. High energy rotating parts are generally considered within the industry to be those which present a risk of uncontained engine failure such as disks, but not blades. Certification standards ensure that blade failures are contained by the engine case structure. The reason for excluding high energy rotating parts from the assessment, is that failure of the parts can create hazards to the airplane beyond that of a typical PDA, which are considered in the design and certification of the airplane per AMC 20-128A. Therefore, special considerations beyond those outlined in Section 3.2 of the EASA CM may be needed to assess the potential for damage to the airplane itself. As the engine is designed to contain blade failures, as was the case in this subject event, the initial radial release energy is absorbed by the engine case structure. Blades that then travel axially through the engine and exit the engine exhaust would not present the same hazard to the airplane as high energy rotating parts.</p> <p>It is further noted that the assumptions outlined in the EASA CM 3.3, hazards to People on the Ground, do not depend on the initial velocity of the part relative the airplane. The analysis conclusions presented in the EASA CM relative to People on the Ground, and the rationale presented for concluding no unsafe condition has been identified for people on the ground, is considered applicable to turbine blades exiting the engine exhaust.</p>	Partly	Within aviation, the magnitude of the risk of departing engine debris has not been determined and translated into regulations. However, non-binding information about departing engine debris is mentioned in Certification Memorandum CM-21.A-A-001. This memorandum does not constitute certification requirements or any legal obligation.
29	Pratt & Whitney	3.2	"Within aviation, the magnitude of the risk of departing engine debris has not been determined and therefore it is not managed..."	<p>Pratt & Whitney recommends reviewing this statement given industry work that has been done on this subject to date. At present, Pratt & Whitney is aware of a few industry documents on the subject of parts departing aircraft and the risk to persons on the ground. The first is the EASA memorandum mentioned earlier in this report (CM-21.A-A-001 Issue 01), which provides a general assessment of the risks to persons on the ground.</p> <p>The other is the Continued Airworthiness Assessment Methodologies (CAAM) Second Report (2005) on Propulsion System and Auxiliary Power Unit Related Safety Hazards. In appendix 4 of this report, a general assessment of this hazard is presented. In that discussion it is concluded that the quantified risk to persons being overflowed "is significantly lower than other hazard ratios calculated in the body of the report; which addresses level 4 threats to persons occupying the airplane."</p> <p>Also reference similar statements made in other areas of the report (page 5, lines 21-27, and page 35, lines 33-39).</p>	Partly	<p>Within aviation, the magnitude of the risk of departing engine debris has not been determined and translated into regulations. However, non-binding information about departing engine debris is mentioned in Certification Memorandum CM-21.A-A-001. This memorandum does not constitute certification requirements or any legal obligation.</p> <p>The argument made by the Dutch Safety Board relates to people on the ground, i.e. third parties, and not to passengers on board of the aeroplane.</p>

No.	Organisation	Section	Text to be corrected (first ... last word)	Argumentation for response	Adopted?	Dutch Safety Board's response
30	Boeing	3.2	However, the risk of death as a result of an accident -a crash- with an aeroplane in the immediate vicinity of a runway is managed by location-specific risk contours. These risk contours are not applicable to the loss of engine parts; however, these contours can be seen as an indication of areas with convergence of air traffic near airports. As mentioned before, the present case showed that the hazard of departing engine parts actually exists. However, the risk for local residents and property to be struck by engine debris is not quantified. Given the degree of feelings of unsafety and the area of convergence of air traffic being situated over the village of Meerssen, the Dutch Safety Board is of the opinion that the <u>local</u> risk of departing engine debris should be identified, assessed and dealt with in order to make a well-considered decision about the acceptance of this <u>local</u> risk.	Boeing notes the investigation determined the location specific risk contours are not applicable to the loss of engine parts, and that the risk for local residence and property has not been quantified. Therefore, if required, it would be more appropriate to consider a location specific risk assessment, that potentially also takes into consideration the risk for property damage, which is not typically considered by the aviation industry as a hazard and is not included in EASA CM No.: CM-21.A-A-001.	No	The section concerns the specific risk of falling engine debris for all civil airports in the Netherlands.
31	Boeing	3.2	The engine failure showed that the hazard of departing engine parts is real, resulting in injured people and damaged property. The present case contributed to the feelings of unsafety of the residents. The <u>local</u> risk of this hazard has not been quantified, therefore a <u>local</u> risk assessment and acceptance by the government can not be adequately accomplished.	Boeing notes the investigation determined the location specific risk contours are not applicable to the loss of engine parts, and that the risk for local residence and property has not been quantified. Therefore, if required, it would be more appropriate to consider a location specific risk assessment, that potentially also takes into consideration the risk for property damage, which is not typically considered by the aviation industry as a hazard and is not included in EASA CM No.: CM-21.A-A-001.	No	The section concerns the specific risk of falling engine debris for all civil airports in the Netherlands.
32	Boeing	Conclusions	The investigation into this serious <u>contained engine failure</u> incident with the departing engine debris, revealed that the turbine of the number one engine of the aeroplane had failed.	To indicate to the reader the engine failure was contained.	Yes	The text has been modified to make clear in the first text block of the conclusion that this was a contained engine failure.
33	Boeing	Conclusions	An operator is not required to implement service bulletins; however, he must be able to present the reasoning to implement or not implement service bulletins. In this way, the operator and its maintenance organisation can ensure the safety of flight. The operator, who had been using the aeroplane for three months at the time of the incident, was not able to present the decision for not implementing service bulletin number 72-462.	Boeing believes the draft report should reference the regulation that requires the event operator document its assessment of service bulletins that are not considered an urgent safety issue, to demonstrate why a service bulletin was or was not incorporated. Boeing suggests removing or appropriately modifying this conclusion, if a regulation is not referenced.	Yes	The text has been removed, as a regulation is not referenced.
34	Boeing	Conclusions	The convergence of air traffic over areas surrounding airports increases the risk of occurrences, like the present case. The fact that these areas of convergence run over the villages of Meerssen, Geverik and Beek shows that its residents are involuntarily exposed to a risk of departing engine debris. The engine failure showed that the hazard of departing engine parts is real, resulting in injured people and damaged property. The <u>local</u> risk of this hazard has not been quantified, therefore a <u>local</u> risk assessment and acceptance by the government can not be adequately accomplished.	Boeing notes the investigation determined the location specific risk contours are not applicable to the loss of engine parts, and that the risk for local residence and property has not been quantified. Therefore, if required, it would be more appropriate to consider a location specific risk assessment, that potentially also takes into consideration the risk for property damage, which is not typically considered by the aviation industry as a hazard and is not included in EASA CM No.: CM-21.A-A-001.	No	The section concerns the specific risk of falling engine debris for all civil airports in the Netherlands.

No.	Organisation	Section	Text to be corrected (first ... last word)	Argumentation for response	Adopted?	Dutch Safety Board's response
35	Boeing	Conclusions	Residents around the airport are exposed to different types of risk, such as departing engine debris, parts departing the aircraft and an accident with an aircraft. However, there has not been a method of integral <u>local</u> risk assessment of these risks. According to the Dutch Safety Board, only in this way an informed decision about the acceptance of this <u>local</u> risk can be made.	Boeing notes the investigation determined the location specific risk contours are not applicable to the loss of engine parts, and that the risk for local residence and property has not been quantified. Therefore, if required, it would be more appropriate to consider a location specific risk assessment, that potentially also takes into consideration the risk for property damage, which is not typically considered by the aviation industry as a hazard and is not included in EASA CM No.: CM-21.A-A-001.	Partly	The section concerns the different types of risks for all civil airports in the Netherlands.
36	AAIB	Appendix F	'Since 19 Dec Third stage LPT duct segments'	Is it correct that this AD was not applicable to ESN 727305 because as SB 72-488 had already been accomplished? If so, please reflect this in the report.	Yes	AD2012-22-16 was not applicable to ESN 727305 because SB 72-488 had been incorporated at the 1999 shop visit. Table 2 has been modified.
37	AAIB	Appendix F	'This AD has been effective since 7 November 2021 ... And damage to the airplane.'	This is the first mention of this AD in the report. Its relationship to the root cause is not made clear in the report. The report does not make it clear whether this AD was embodied (or required to be embodied) on ESN 727305, or if it was due to be embodied at the next shop visit. It is not listed in Table 2 where relevant SBs and ADs are described. Please consider including additional information to assist the reader in understanding the relevance of this AD.	Yes	In 2010, the last shop visit occurred on the affected engine which was prior to the release of this AD. Therefore the AD had not been complied with. It is presumed it was due to be incorporated at the next shop visit. The text has been modified.
38	Boeing	Appendix F	This AD has been effective since 7 November 2012 ²¹ and requires dimensional inspections of LPT 3rd stage vanes and the rear turbine case, inspection of LPT 4th stage vanes at the next LPT overhaul and removal of vanes with non-conforming airfoil fillet radii and vanes with more than one strip and recoat repair. This AD also requires disassembly and reassembly of the 2nd stage high-pressure turbine (HPT) rotor and 3rd stage LPT rotor at the next HPT and LPT overhauls.	Boeing suggests the noted AD effective data of 7 November 2021 be verified.	Yes	The text has been modified.
39	Boeing	Appendix F		Boeing suggests the event operator's name be removed from this figure.	Yes	The figure has been modified.
40	AAIB	Appendix F	'HPT Cooling SB 72-462 not incorporated. Paperwork discrepancy, paperwork indicated up-change HPT hardware incorporated prior to 2009 SV.'	Although mentioned here in Figure 24 the report does not explore the paperwork discrepancy which indicated ESN 727305 already had up-change components. It is understood that the paperwork discrepancy referred to the part number for the dog bone seal. The report does not explore the degree to which this discrepancy may have influenced decision-making by previous owners/operators about whether or not to embody SB 72-462 (as replacement of the dog bone seal is part of SB 72-462). Some clarification on this issue may assist readers.	Yes	A text has been added for clarification.
41	AAIU	2.6.3 / Appendix F		With regards to the engine serial P727305 information (page 19), timeline (page 52) & history, the time of installation on the B747 serial 24975 aircraft may be added.	No	The date that the affected engine was mounted under the wing of the Boeing 747 (with serial number 24975) is not known to the Dutch Safety Board.
42	AAIU	Appendix F		The engine timeline on page 52 references a Longtail Engine Shop Visit (ESV) during the year 2009, the factual & analysis sections reference the operation of the aircraft since a 3 months leasing period in the operator fleet (on pages 5, 24, 32). It may be interesting to indicate whether this engine #1 serial P727305 remained under the operator supervision during this time frame.	Yes	The timeline has been modified.