

INCOMING INSPECTION REPORT

MS6001FA (GE Frame 6FA) 2nd Stage Bucket Set

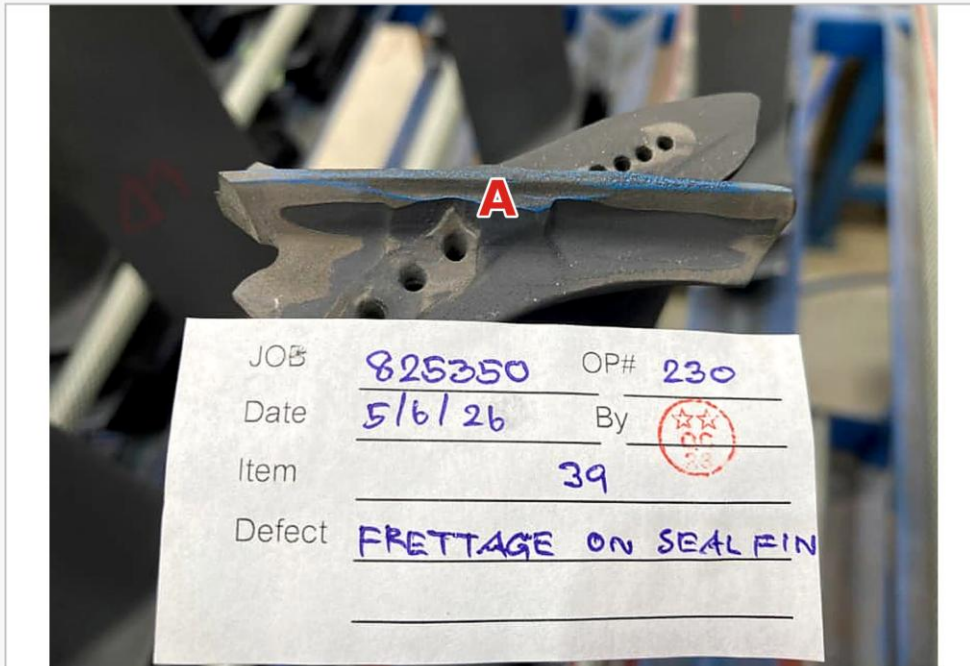
Customer	Nghi Son Refinery & Petrochemical LLC
Customer P.O. No.	WO-1004061634-WO-1004061642
Component	MS6001FA 2nd Stage Bucket
Engine Type	MS6001FA (GE Frame 6FA)
Original Part Number	131E4411 P1H1
Quantity Received	92 pieces (1 complete set)
Material	GTD 111
As Received Coating	MCrAlY coating
Total Running Hours	21,605 hours (from August 2023)
Fuel Hours	Diesel: 3,878 / LPG: 17,737
Previous Repairs	1
Service Cycle	2
Report Date	26 June 2026
Repair Classification	HEAVY REPAIR: LEVEL 9 (SEVERE HEAVY REPAIR)
Severity Category	Maximum of Heavy Repair band (Score 22 of 22)

Reviewed and approved by:

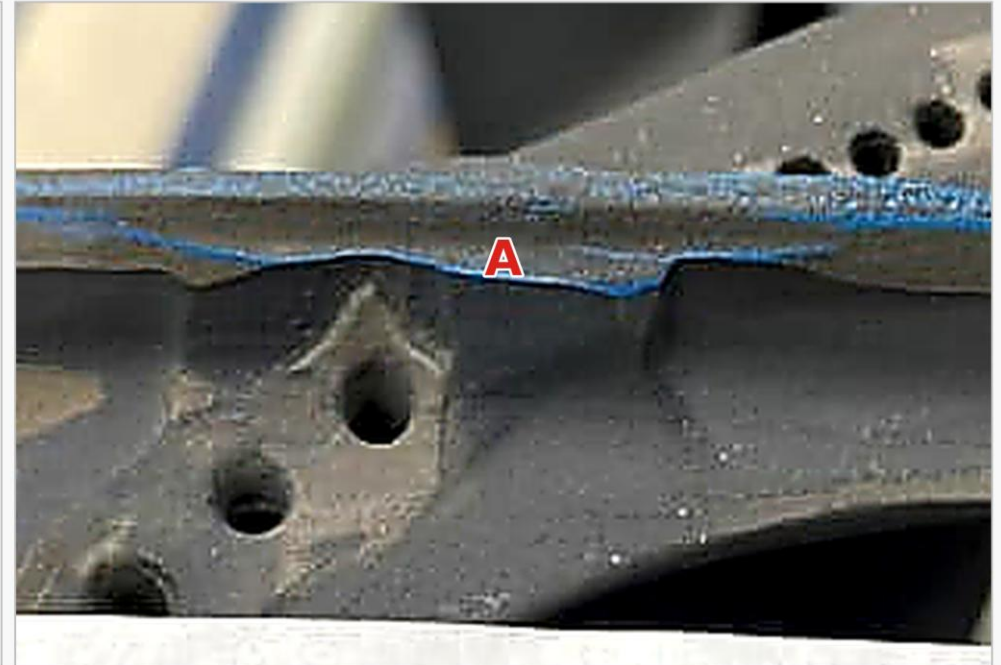


Paul McGuire
Engineering Manager

FIG. 13 - FRETTAGE AND DIMENSIONAL LOSS - SEAL FIN



ORIGINAL INSPECTION PHOTOGRAPH



MAGNIFIED VIEW A

SEAL-FIN HEIGHT: DIMENSIONALLY REJECTED ON 92/92 | FULL-SET WELD + MACHINING/EDM

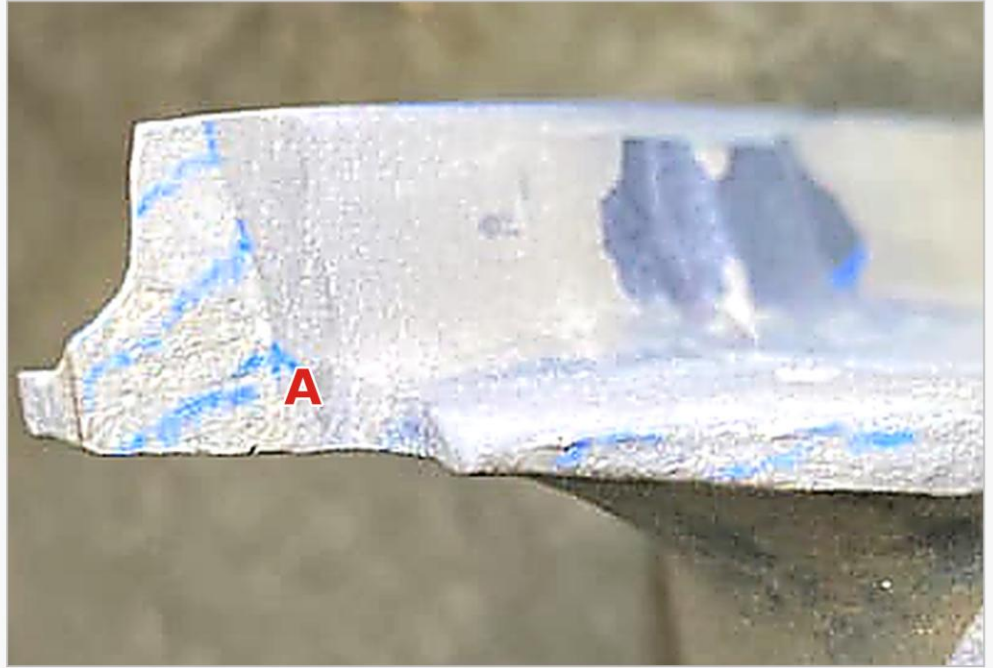
HEAVY REPAIR BASIS

The photographed frettage is on the tip seal fin, a functional hot-gas sealing surface, not a cosmetic edge.
The 92/92 rejection is the report's set-wide dimensional result; it is not a measurement derived from this photograph.
Restoration requires weld build-up and precision machining/EDM to recover height and profile, followed by repeated FPI.

FIG. 15 - FRETTAGE - Z-NOTCH INTERLOCK



ORIGINAL INSPECTION PHOTOGRAPH



MAGNIFIED VIEW A

Z-NOTCH: DIMENSIONALLY REJECTED ON 92/92 | SHROUD ENGAGEMENT BELOW 50% ON 23/92

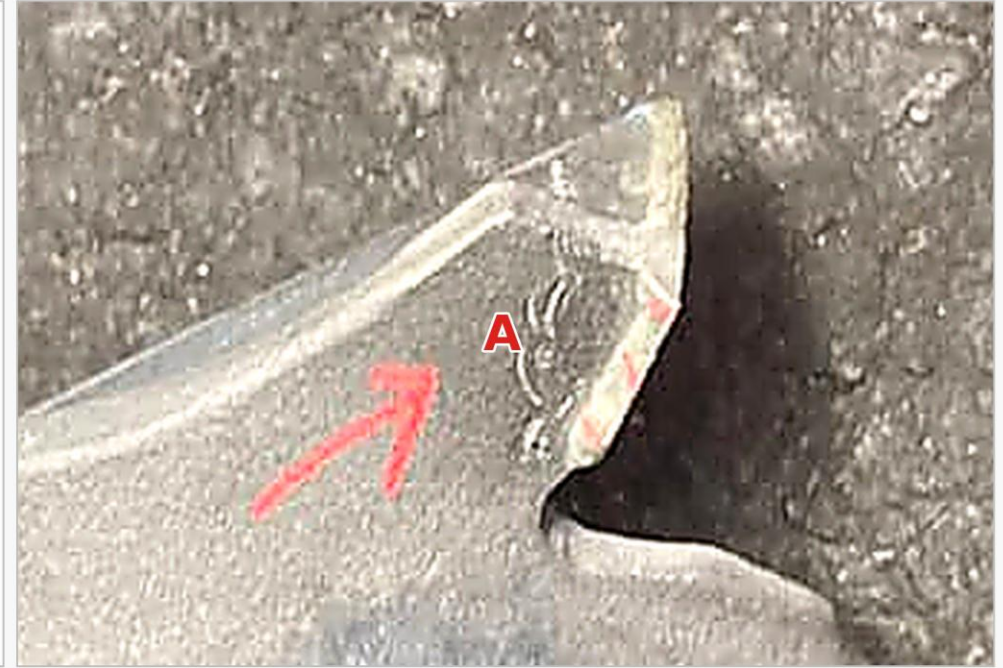
HEAVY REPAIR BASIS

The Z-notch locks adjacent bucket tips into a continuous ring that controls vibration, tip stiffness, and leakage. The full-set rejection and 23/92 engagement result are report data; this photograph documents the fretted interface. Material must be rebuilt and the mating profile recreated by weld and EDM, with dimensional and FPI/NDT verification.

FIG. 16 - WELDMENT AND CONTACT WEAR - Z-NOTCH



ORIGINAL INSPECTION PHOTOGRAPH



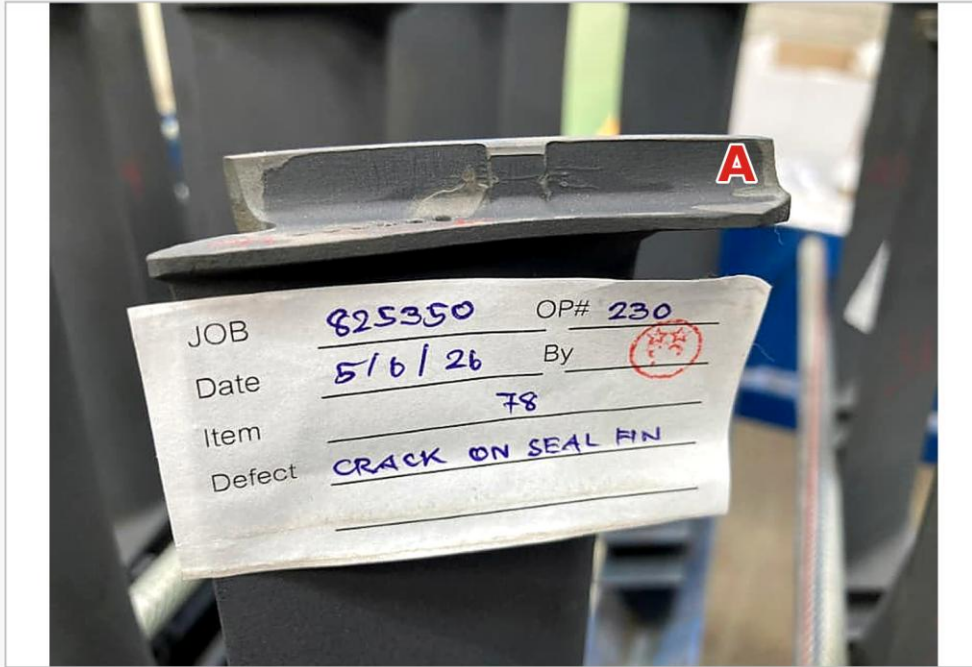
MAGNIFIED VIEW A

ENGAGEMENT LIMIT: 50% | MINIMUM -20.82% AT ITEM 75 | POSITIVE INTERLOCK CONTACT LOST

HEAVY REPAIR BASIS

The photograph records weldment/contact wear at the Z-notch; the minimum value is the report's set-wide extreme.
At Item 75, below-zero engagement means the interlock no longer makes positive contact with its neighbouring bucket.
Recovery requires Z-notch contact-point build-up, EDM profile recreation, and proof of restored engagement—not blending.

FIG. 17 - CRACK - SEAL FIN, ITEM 78



ORIGINAL INSPECTION PHOTOGRAPH



MAGNIFIED VIEW A

SEAL-FIN CRACK: ITEM 78 | DISCRETE CRACKS: 5/92 TOTAL (1 SEAL FIN + 4 ANGEL WINGS)

HEAVY REPAIR BASIS

The marked indication is the report-identified seal-fin crack on Item 78, confirmed during fluorescent penetrant inspection.

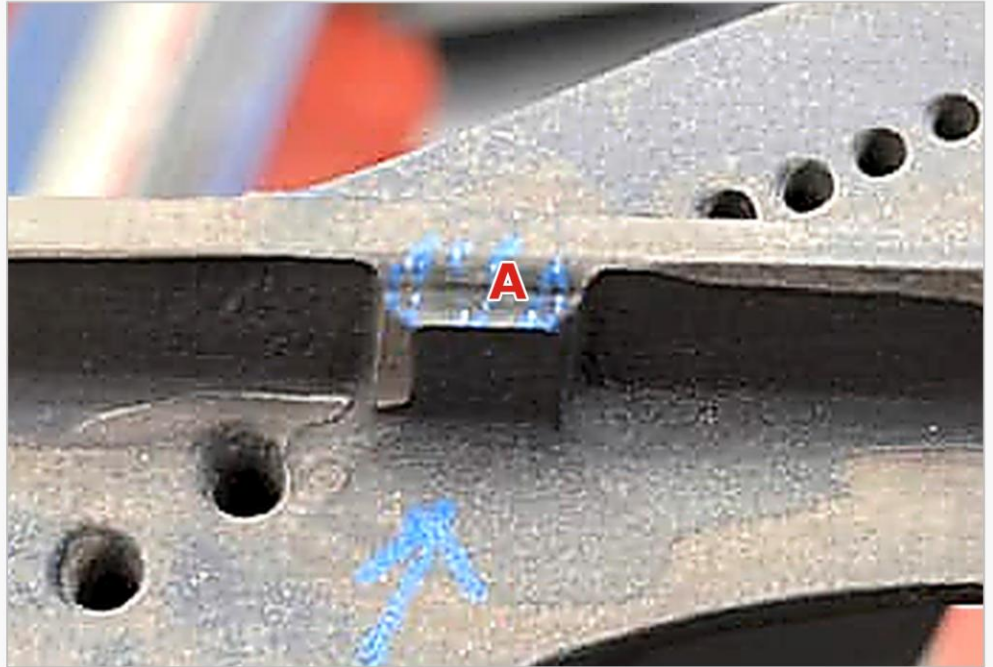
A crack in a critical tip-sealing feature must be excavated completely; surface blending alone cannot remove the risk.

The repair route is controlled excavation, weld restoration, profile recovery, and repeated FPI confirmation.

FIG. 18 - FRETTAGE AND WEAR - CUTTER TEETH



ORIGINAL INSPECTION PHOTOGRAPH



MAGNIFIED VIEW A

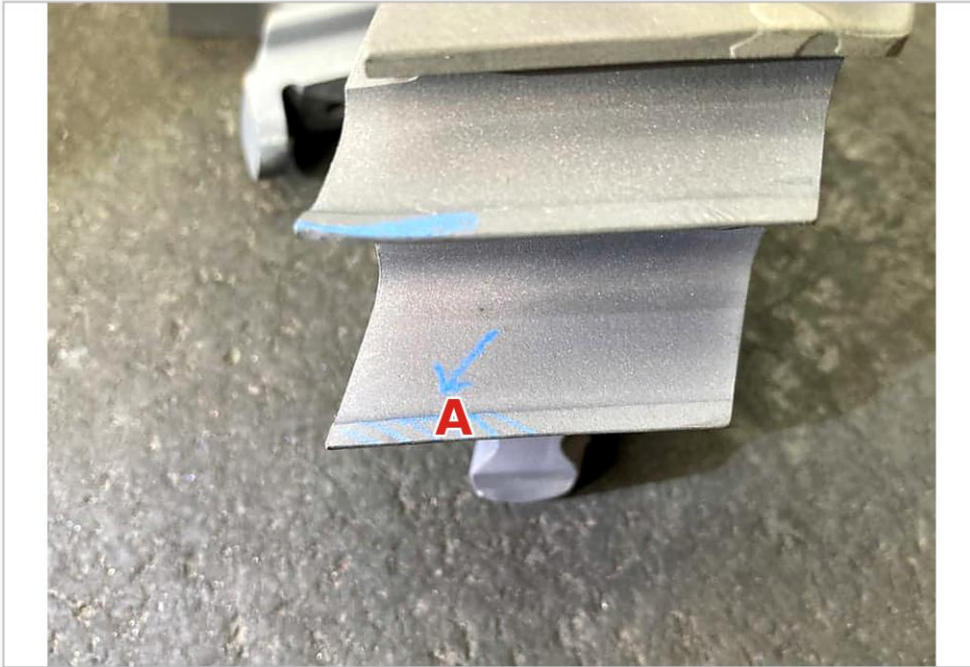
SEAL FIN / CUTTER-TOOTH FRETTAGE AND WEAR: 92/92 | MULTI-FEATURE RECONSTRUCTION

HEAVY REPAIR BASIS

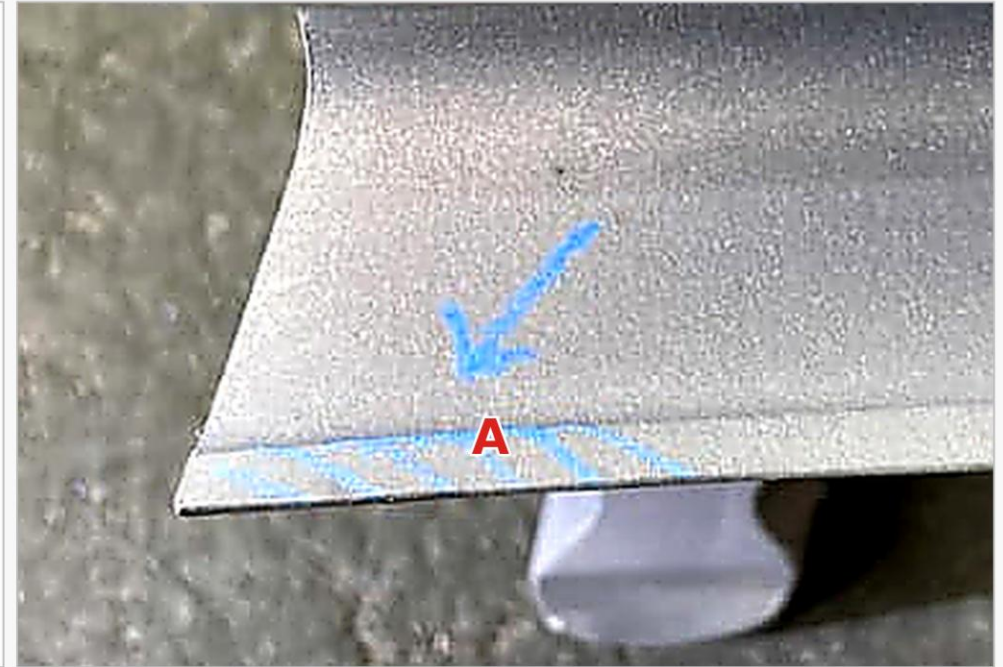
Cutter teeth establish tip clearance by cutting a controlled track in the shroud; lost geometry increases tip leakage. The 92/92 frequency is the report's full-set finding and is not inferred from the size of the photographed indication.

Weld build-up, machining/EDM, heat treatment, dimensional verification, and final balance control are required.

FIG. 19 - DEFORMATION AND FRETAGE - ANGEL WING



ORIGINAL INSPECTION PHOTOGRAPH



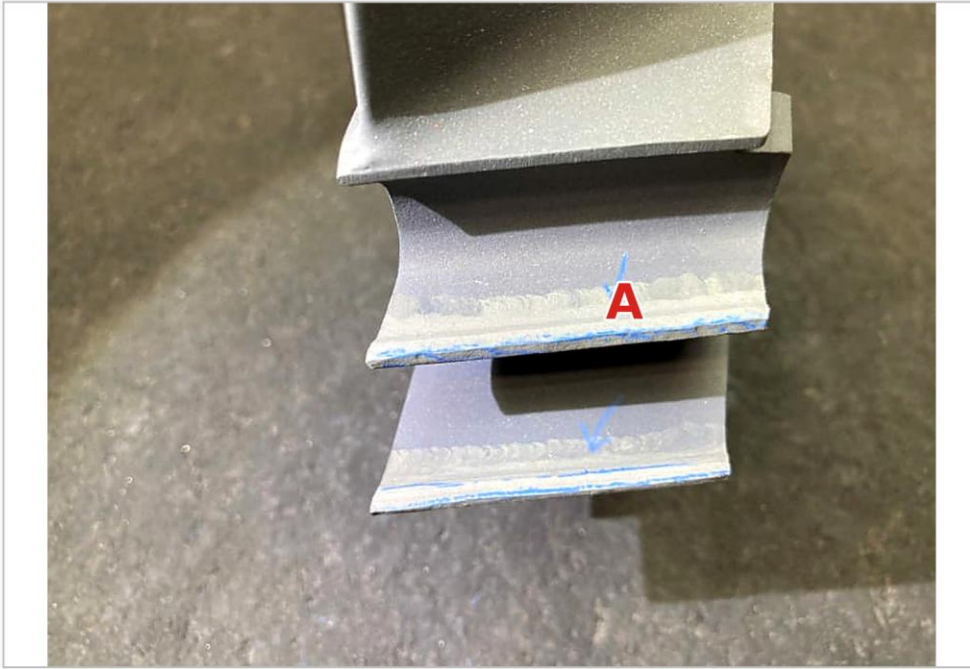
MAGNIFIED VIEW A

ANGEL-WING HEIGHT: DIMENSIONALLY REJECTED ON 92/92 | FRETAGE/DEFORMATION ACROSS FULL SET

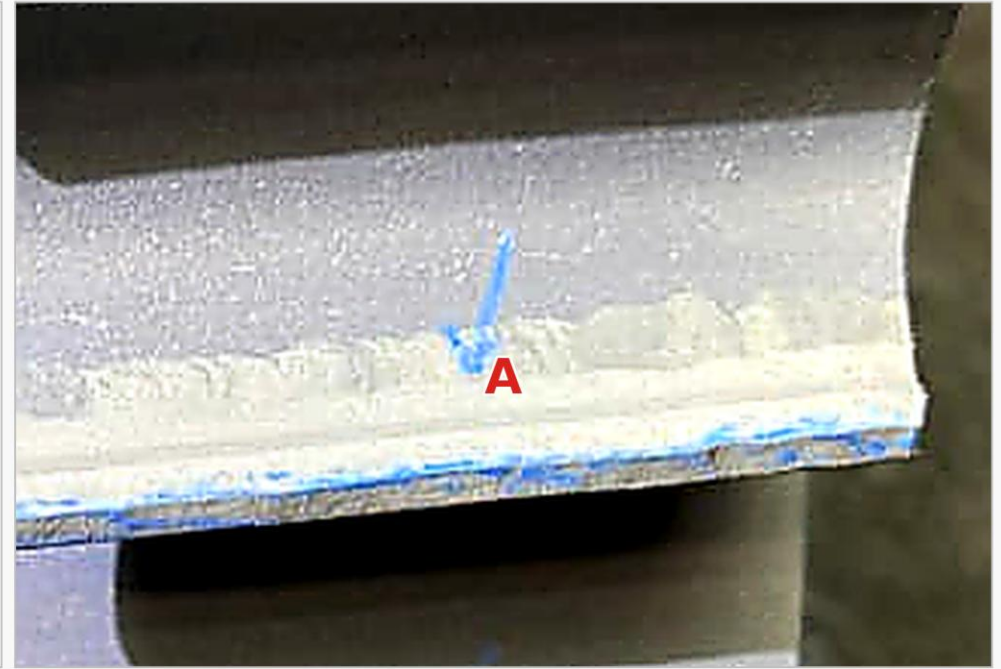
HEAVY REPAIR BASIS

The angel wing is a wheelspace seal that limits hot-gas ingestion toward the rotor; its profile is function-critical. The full-set rejection is the report's dimensional conclusion; the image shows the recorded edge deformation/fretage. Weld build-up and machining are required to recreate height and profile, with crack excavation where indications exist.

FIG. 20 - FOREIGN OBJECT DAMAGE - ANGEL WING



ORIGINAL INSPECTION PHOTOGRAPH



MAGNIFIED VIEW A

ANGEL-WING HEIGHT: REJECTED ON 92/92 | PHOTOGRAPH DOCUMENTS FOD AT A CRITICAL SEAL

HEAVY REPAIR BASIS

The marked surface is the report-captioned angel-wing FOD location; no defect depth is assigned from the photograph. Repair severity follows the feature's wheelspace-sealing function and the full-set dimensional rejection—not visual size alone. Engineering disposition must recover sound material and specified profile, then verify the area by FPI and dimension.

FIG. 22 - DEFORMATION AND CRACK - ANGEL WING, ITEM 7



ORIGINAL INSPECTION PHOTOGRAPH



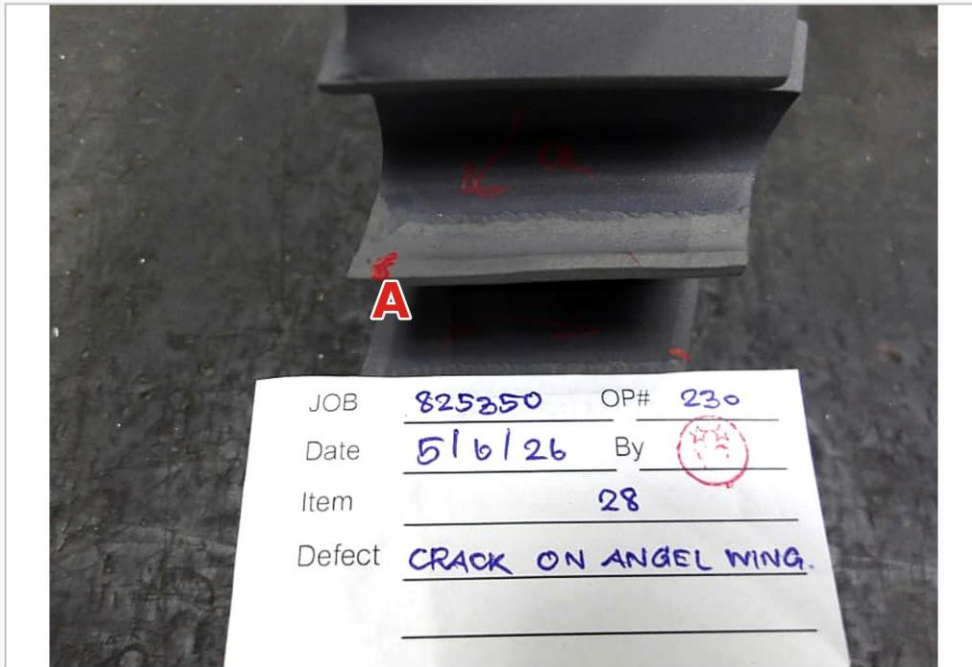
MAGNIFIED VIEW A

ANGEL-WING CRACKS: ITEMS 7, 28, 29 AND 33 | 4/92 | ITEM 7 SHOWN

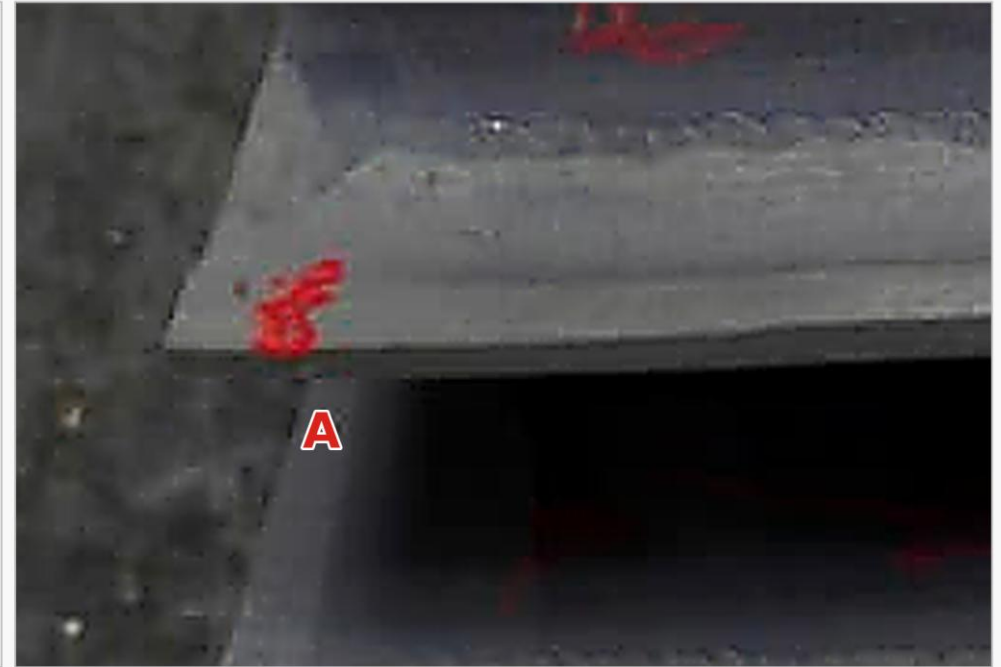
HEAVY REPAIR BASIS

This report photograph identifies deformation and a crack at the Item 7 angel wing, one of four affected buckets. Crack repair is additive to the full-set angel-wing height rejection and population-wide fretting/deformation scope. The required route is complete crack excavation, weld repair, profile machining, and repeated FPI verification.

FIG. 23 - CRACK - ANGEL WING, ITEM 28



ORIGINAL INSPECTION PHOTOGRAPH



MAGNIFIED VIEW A

ANGEL-WING CRACKS: ITEMS 7, 28, 29 AND 33 | 4/92 | ITEM 28 SHOWN

HEAVY REPAIR BASIS

The photograph records the Item 28 angel-wing crack, independently illustrating the report's multi-item crack burden. At a wheelspace-sealing edge, an indication must be removed to sound metal and cannot be accepted as cosmetic wear. Controlled excavation, weld restoration, machining to recover geometry, and FPI/NDT confirmation are required.

FIG. 24 - EXISTING WELDMENT - ANGEL WING



ORIGINAL INSPECTION PHOTOGRAPH



MAGNIFIED VIEW A

FULL-SET ANGEL-WING RESTORATION | 92/92 HEIGHT REJECTION | 4 CRACK REPAIRS

HEAVY REPAIR BASIS

The as-inspected photograph documents weldment at the angel-wing edges; it is retained as evidence of prior intervention.

Current disposition still requires full-set dimensional recovery, plus excavation and weld repair of four cracked buckets.

Final acceptance depends on recreated seal geometry, repeated NDT, heat treatment, CMM/dimensional checks, and set balance.

1. Executive Summary

Ninety two (92) MS6001FA 2nd stage buckets were received from Nghi Son Refinery and Petrochemical LLC for incoming inspection. The set is one complete turbine stage. All 92 buckets are original part number 131E4411 P1H1, GTD 111 material, supplied with an MCrAlY coating as received. The customer supplied history records 21,605 total running hours from August 2023. This includes 3,878 diesel hours and 17,737 LPG hours. The set has one previous repair and is in service cycle 2.

The incoming inspection found damage on every bucket in the set. The damage is concentrated on the most safety critical and dimensionally controlled features of the bucket. These features are the seal fin, the cutter teeth, the Z-notch and shroud interlock, the angel wings, and the airfoil. The inspection recorded objective dimensional rejection on five separate control features across the set. It also recorded discrete crack indications and a severe loss of Z-notch shroud engagement on a large group of buckets.

The repair classification is **HEAVY REPAIR: LEVEL 9 (SEVERE HEAVY REPAIR)**. The measured score is 22 of 22 within the Heavy Repair band. This is the top of the Heavy Repair band. The set is held below Level 10, which is the beyond economical repair and replacement level, only because the GTD 111 base material is still repairable. The parts can be saved and returned to service through this repair.

The restoration is not a blend repair and it is not a localized correction. The restoration requires full set weld build up, EDM and machining geometry restoration on multiple critical interfaces, three heat treatment cycles, at least five FPI/NDT control points, complete coating removal and reapplication, moment weighing, and a balance chart. The classification is supported by the number of affected buckets, the number of affected critical locations, the number of dimensional rejections, the weld reconstruction scope, and the inspection and heat treatment burden detailed in this report.

Summary of objective rejection findings

Control feature / finding	Affected	Share of set
Seal fin height dimensionally rejected	92 of 92	100%
Z-notch dimensionally rejected	92 of 92	100%
Angel wing height dimensionally rejected	92 of 92	100%
Z-notch shroud engagement below 50% limit	23 of 92	25%
Wall thickness dimensionally rejected	10 of 92	11%
Discrete crack indications	5 of 92	5%
Weld restoration required (Weld and Blend / Weld and Machining)	92 of 92	100%

2. Introduction

The MS6001FA 2nd stage bucket operates in the hot gas path of the gas turbine. It is exposed to high temperature gas flow, high centrifugal load, vibration, thermal cycling, and gas path contamination. The Z-notch and shroud form a continuous interlocking

ring at the bucket tip. This interlock controls bucket vibration, tip sealing, and gas path leakage. The seal fin and cutter teeth control tip clearance and sealing. The angel wings control wheel space sealing. These are all critical control surfaces. Loss of dimension on any of these surfaces reduces sealing performance, increases leakage, and increases vibratory stress on the airfoil.

This report summarizes the incoming inspection findings for the complete set of 92 buckets. It then applies the UNEW repair severity classification method to the measured condition. The method assigns the repair level from the condition of the component, the affected feature, the location of the damage, and the restoration method that is required to return the component to a serviceable condition. The method does not assign the repair level from a single defect count or from the names of process steps. Final release of the set is subject to completed repair results, dimensional verification, FPI/NDT results, heat treatment records, moment and balance verification, and final acceptance documentation.

3. Inspection Summary

Customer P.O. No.	WO-1004061634-1004061642-HGP-FN	Engine Type	MS6001FA
Date of Report	26 June 2026	Component Type	2nd Stage Bucket
Quantity Received	92 pieces	Part Number	131E4411 P1H1
As Received Coating	MCrAlY coating	Material Type	GTD 111
Incoming Packing	Good	Cooling Configuration	10 cooling holes
Total Running Hours	21,605 hours	Classification	HEAVY REPAIR: LEVEL 9
Diesel Hours	3,878 hours	Repair Category	Severe Heavy Repair
LPG Hours	17,737 hours	Scrap Recommendation	None at incoming stage
Previous Repairs	1	Disposition	Repair per Level 9 scope

4. Numeric Defect Summary

The repair level is set by the combined repair work the complete set needs. This includes the critical tip and seal features that must be rebuilt, the weld, machine, and EDM work required, the repeated heat treatment and inspection steps, and the number of buckets affected. The table below lists each measured finding, the restoration it needs, and why it places the set in the Level 9 band.

No.	Measurement / Defect Basis	Numeric Finding	Required Restoration / Repair Process	Level 9 Justification
1	Total received components	92 buckets received as one complete stage set, P/N 131E4411	Full set inspection, segregation, defect mapping,	Level 9 is applied to the complete set because repair

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No.	Measurement / Defect Basis	Numeric Finding	Required Restoration / Repair Process	Level 9 Justification
		P1H1, GTD 111 material, MCrAlY coated as received.	dimensional verification, repair routing, final moment weigh and balance chart.	control, balance, and release must be managed as one turbine bucket set, not as single bucket touch up.
2	Service exposure and repair history	21,605 total running hours from August 2023; 3,878 diesel hours; 17,737 LPG hours; 1 previous repair; service cycle 2.	Material evaluation, solution heat treatment, repairability review, repeated NDT, and final acceptance inspection before release.	High accumulated service exposure and a second service cycle increase engineering risk and support severe heavy classification when combined with full set interface restoration.
3	Seal fin and cutter tooth condition	92 of 92 buckets show seal fin and cutter tooth fretting and wear.	Weld build up of tip seal fin; restoration of cutter tooth areas; machine and EDM to restore seal fin and cutter tooth configuration.	Critical sealing features require weld build up plus machine and EDM, not simple blending. This is a Level 9 repair driver.
4	Seal fin height (critical dimension)	Seal fin height dimensionally rejected on 92 of 92 buckets (100%). Full set rejection of a critical sealing dimension.	Recover seal fin height and profile by weld build up, machine and EDM, dimensional inspection, and repeated FPI confirmation.	A full set dimensional rejection on a critical sealing feature supports the maximum dimensional restoration score and Level 9 classification.
5	Z-notch and shroud condition	Z-notch dimensionally rejected on 92 of 92 buckets (100%). Z-notch fretting recorded across the full set.	Weld build up of Z-notch and shroud areas; EDM to recreate Z-notch and shroud profiles; dimensional restoration and NDT.	The Z-notch is a critical engagement and load transfer feature. A full set rejection requires controlled restoration of the interface geometry.
6	Z-notch shroud engagement	23 of 92 buckets (25%) show shroud engagement below the 50% limit. Minimum recorded engagement is - 20.82% (item 75). 1 bucket lost positive interlock contact and 4 buckets fell at or below 25% engagement.	Weld build up of the Z-notch contact point to restore engagement to within the required limit, followed by EDM and dimensional verification.	Loss of interlock engagement weakens the continuous tip ring, vibration control, and tip sealing. Several buckets lost contact entirely. This is a primary severity driver of this set.

INCOMING INSPECTION REPORT

No.	Measurement / Defect Basis	Numeric Finding	Required Restoration / Repair Process	Level 9 Justification
7	Angel wing condition	Angel wing height dimensionally rejected on 92 of 92 buckets (100%). Fretage and deformation across the full set. Discrete cracks on items 7, 28, 29, and 33.	Weld build up of angel wings; machine to recreate angel wing dimensions; excavation and weld repair of cracked buckets; FPI verification.	The angel wing is a critical wheel space sealing feature. Full set restoration plus crack repair is required across the set.
8	Seal fin crack	Discrete crack indication on item 78 seal fin. Recorded during fluorescent penetrant inspection.	Excavate the crack, weld repair the affected area, and verify by FPI.	A crack at a sealing feature requires controlled excavation and weld repair, not blending.
9	Wall thickness	Wall thickness dimensionally rejected on 10 of 92 buckets (11%). Thinnest readings recorded were 0.62 mm and 0.65 mm at the trailing edge concave region.	Blend or weld repair at the affected positions as dispositioned by engineering, with FPI verification of the airfoil pressure boundary.	Localized wall loss on the airfoil pressure boundary at multiple buckets adds to the restoration burden.
10	Coating condition	MCrAlY coating present as received. Full chemical strip of the external gas path coating and diffused MCrAlY reapplication are required.	Chemical strip, incoming solution heat treatment, heat tint, recoat by HVOF MCrAlY, post coat heat treatment, and pulse thermography.	A complete coating removal and reapplication cycle adds a full coating process and additional heat treatment and inspection burden.
11	Airfoil surface condition	Surface fretage and corrosion across the set. Base material remains sound.	Controlled cleaning, blending of affected surface, and FPI verification.	Surface restoration is required across the full airfoil population.
12	Material evaluation	GTD 111 confirmed by metallurgical sectioning of the as-received coupon taken from item 92 (shroud). Microstructure is normal for the alloy. Base material is sound and suitable for repair after acid strip.	Controlled cleaning, metallurgical acceptance, heat treatment sequence, and final engineering disposition.	The material is repairable. This is the basis for repair rather than replacement, and confirms the set can be saved and returned to service.
13	Required welding and material build up scope	Multi feature weld build up across seal fin, cutter teeth, Z-notch, shroud, and angel wing, plus 23	Weld build up, blend, machine and EDM, intermediate FPI, post weld solution	This is not one local weld. It is multi feature material reconstruction across

No.	Measurement / Defect Basis	Numeric Finding	Required Restoration / Repair Process	Level 9 Justification
		engagement build ups and 5 crack repairs.	heat treatment, and final inspection.	the complete bucket set.
14	Required machining and EDM scope	Machine and EDM to restore seal fin and cutter tooth configuration, recreate Z-notch and shroud profiles, and recreate angel wing dimensions.	Precision machine and EDM, CMM and dimensional verification, profile restoration, final visual and FPI inspection.	Major geometry recovery of multiple critical features supports Level 9, because function depends on restored sealing, engagement, and fit up dimensions.
15	Heat treatment and inspection burden	Three heat treatment cycles (incoming solution, post weld solution, final age). At least five FPI/NDT control points. Pulse thermography after coating.	Full thermal recovery sequence, repeated NDT, dimensional inspection, CMM, final QA, and balance chart.	Multiple heat treatment and NDT cycles create high repair complexity and engineering risk, consistent with Level 9 severe heavy repair.
16	Set level balance and release control	Moment weigh of all 92 buckets, balance chart, and blade location labeling required for assembly.	Moment weigh, balance chart, blade location labeling, final visual inspection, final report, and controlled packing.	Set level balance and positional control are required after restoration. This confirms the repair is a complete set severe restoration process.

5. Dimensional Measurement Summary

A full dimensional inspection was performed on all 92 buckets. The table below gives the measured range for each controlled dimension across the complete set. The range is reported as minimum to maximum. The Z-notch shroud engagement result is addressed separately in Section 13 because it is the primary severity driver of this set. The classification is not based on dimensional spread alone. It is based on the combined damage and restoration requirement across the critical features.

Dimension	Minimum	Maximum	Measured Range	Measured Items
A (overall length)	286.38 mm	286.57 mm	0.19 mm	92
B (platform to section)	55.97 mm	56.39 mm	0.42 mm	92
C	29.58 mm	29.84 mm	0.26 mm	92
D	30.23 mm	30.82 mm	0.59 mm	92
E	47.27 mm	48.09 mm	0.82 mm	92
F	2.04 mm	2.99 mm	0.95 mm	92
G	36.73 mm	37.08 mm	0.35 mm	92
Z-notch CC shroud height	275.58 mm	276.79 mm	1.21 mm	92
Z-notch CV shroud height	274.78 mm	275.27 mm	0.49 mm	92

Dimension	Minimum	Maximum	Measured Range	Measured Items
Concave Z-notch thickness	1.34 mm	2.46 mm	1.12 mm	92
Convex Z-notch thickness	1.43 mm	2.71 mm	1.28 mm	92

6. Repair Severity Measurement Basis

The UNEW repair severity method classifies a set as Severe Heavy Repair (Level 9) when severe damage in multiple critical areas requires major material reconstruction, major dimensional restoration, multiple NDT and FPI cycles, heat treatment, and engineering disposition. The Level 9 band covers a total score of 18 to 22. The scoring below applies the measurable criteria to the Stage 2 set incoming condition. The result is the maximum score within the Heavy Repair band.

Scoring scale and band limits. The method scores five categories, and each category carries a defined maximum: Welding / Material Build Up (maximum 5), Dimensional Restoration (maximum 5), Coating / Base Metal Condition (maximum 5), Cooling / Gas Path / Sealing Recovery (maximum 3), and Inspection / Heat Treatment / Engineering Risk (maximum 5). A Score of 5 in the Coating / Base Metal Condition category is reserved exclusively for near scrap base metal, which is by definition beyond economical repair and places the component at Level 10 (replacement). For any component that remains repairable, that category cannot exceed Score 4. The maximum score attainable by a component that is still repairable is therefore $5 + 5 + 4 + 3 + 5 = 22$. A score of 22 is not a partial result on an open ended scale. It is the ceiling of the repairable range, one disposition increment below the Level 10 replacement threshold.

Position of this set against the scale. This set scored 22. Four of the five categories are at their category maximum: Welding / Material Build Up (5 of 5), Dimensional Restoration (5 of 5), Cooling / Gas Path / Sealing Recovery (3 of 3), and Inspection / Heat Treatment / Engineering Risk (5 of 5). The fifth category, Coating / Base Metal Condition, is held one increment below its maximum at 4 of 5. It is held there not because the coating or surface attack is limited, but solely because a Score of 5 would require near scrap base metal and would move the set to Level 10. The set is therefore at the maximum severity that a repairable bucket set can carry, and it is retained in the repairable range only by the metallurgical confirmation that the GTD 111 base material remains sound. This measured condition cannot be reconciled with a standard or medium repair classification: a standard or medium repair applies to localized wear that can be corrected by blending or by a single local weld, whereas this set requires full set weld reconstruction of multiple critical interfaces, full coating strip and reapplication, three heat treatment cycles, and at least five FPI / NDT control points, with full set dimensional rejection of three critical control dimensions.

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Category	Score 5 / Level 9 Threshold	Stage 2 Set Incoming Measurement and Repair Requirement	Score
Welding / Material Build Up	Score 5 applies when severe material loss, seal surface loss, edge or interface loss, or multi feature reconstruction is required.	92 of 92 buckets (100%) require weld restoration. Weld and Machining and Weld and Blend are required on seal fin, cutter teeth, Z-notch, shroud, and angel wing. In addition, 23 buckets require weld build up of the Z-notch contact point to restore lost shroud engagement, and 5 buckets require crack excavation and weld repair. This is multi feature reconstruction across the complete set.	5
Dimensional Restoration	Score 5 applies when critical geometry must be rebuilt to recover sealing, engagement, fit, alignment, or set level balance.	Three critical control dimensions are rejected on the full set: seal fin height (100%), Z-notch (100%), and angel wing height (100%). In addition, 23 of 92 buckets fall below the 50% Z-notch engagement limit, and 10 of 92 buckets are rejected on wall thickness. Restoration requires weld build up, machine and EDM to recreate seal fin, cutter tooth, Z-notch, shroud, and angel wing geometry, CMM verification, moment weigh, and balance chart.	5
Coating / Base Metal Condition	Score 4 applies when coating removal and reapplication, surface attack removal, cleaning, heat treatment, and engineering review are required. Score 5 is reserved for near scrap base metal.	The set is MCrAlY coated as received and requires a full chemical strip of the external gas path coating and diffused MCrAlY reapplication, with post coat heat treatment and pulse thermography. The airfoil shows surface fretting and corrosion. The GTD 111 base material is confirmed sound with no substrate alloy depletion and is suitable for repair after acid strip. The base metal is therefore not near scrap, which holds this category at Score 4.	4
Cooling / Gas Path / Sealing Recovery	Score 3 applies when gas path sealing, leakage control, cutter tooth, seal fin, shroud and Z-notch engagement, or clearance control features require restoration across the set.	92 of 92 buckets (100%) show seal fin, cutter tooth, Z-notch, and angel wing fretting. These features control gas path sealing, bucket engagement, contact stability, and set assembly fit. 23 buckets show reduced shroud engagement. Required actions include seal and cutter restoration, Z-notch and shroud profile recovery, angel wing dimensional recovery, and final set level moment and balance verification.	3
Inspection / Heat Treatment / Engineering Risk	Score 5 applies when high repair risk requires multiple NDT and FPI stages, multiple heat treatment cycles,	At least five FPI/NDT control points are required: incoming, after defect preparation, after weld and profile restoration, after post weld solution heat treatment, and after final age heat	5

Category	Score 5 / Level 9 Threshold	Stage 2 Set Incoming Measurement and Repair Requirement	Score
	dimensional verification, engineering disposition, and set level balance control before release.	treatment. At least three heat treatment cycles are required: incoming solution, post weld solution, and final age. The coating cycle adds post coat heat treatment and pulse thermography. Final controls include CMM, moment weigh, balance chart, blade location labeling, final report, and controlled packing.	
Total Score Basis	Welding / Material Build Up 5 + Dimensional Restoration 5 + Coating / Base Metal 4 + Cooling / Gas Path / Sealing 3 + Inspection / Heat Treatment / Engineering Risk 5 = 22 points. The 22 point result is the maximum of the Level 9 Severe Heavy Repair band. It places the set immediately below the Level 10 beyond economical repair and replacement threshold. The set is held at Level 9, and not at Level 10, only by the metallurgical confirmation that the GTD 111 base material remains repairable.		22

Classification conclusion: the combined measured score is 22 of 22 with three Score 5 drivers. The repair requirement is **HEAVY REPAIR: LEVEL 9 (SEVERE HEAVY REPAIR)**, at the maximum severity of the Heavy Repair band.

7. Damage Summary and Disposition

Damage Category	Finding (As Inspected)	Disposition
Seal Fin and Cutter Teeth	Seal fin and cutter tooth fretting and wear on 92 of 92 buckets. Seal fin height dimensionally rejected on 92 of 92 buckets.	Weld build up, machine and EDM restoration, FPI, and dimensional verification.
Z-notch and Shroud Interlock	Z-notch fretting on 92 of 92 buckets. Z-notch dimensionally rejected on 92 of 92 buckets. 23 of 92 buckets below the 50% shroud engagement limit, minimum - 20.82%.	Weld build up, EDM to recreate Z-notch and shroud profiles, restore interlock engagement, and repeated FPI/NDT.
Angel Wing	Angel wing fretting and deformation on 92 of 92 buckets. Angel wing height dimensionally rejected on 92 of 92 buckets. Discrete cracks on items 7, 28, 29, and 33.	Weld build up, machine to recreate angel wing dimensions, crack excavation and weld repair, and profile restoration.
Seal Fin Crack	Discrete crack indication on item 78 seal fin.	Excavate, weld repair, and FPI verification.
Airfoil Surface and Wall Thickness	Airfoil surface fretting and corrosion on 92 of 92 buckets. Wall thickness dimensionally rejected on 10 of 92 buckets, thinnest reading 0.62 mm.	Controlled cleaning, blend or weld repair of affected positions as dispositioned by engineering, and FPI verification.
Coating	MCrAlY coating present as received.	Full chemical strip of external gas path

Damage Category	Finding (As Inspected)	Disposition
		coating, diffused MCrAlY reapplication, post coat heat treatment, and pulse thermography.
Material Condition	GTD 111 base material confirmed. Microstructure normal. Sectioned coupon considered suitable for repair after acid strip.	Repairable with Level 9 heavy repair scope and final inspection verification.

8. Engineering Evaluation and Recommendation

8.1 Function and Consequence of the Affected Features

Each rejected feature has a job in the turbine. The list below explains what each feature does and what the measured loss means for the engine if it is not restored.

- **Seal fin.** The seal fin sits at the bucket tip and controls the gap between the tip and the shroud. When the seal fin is worn down, more hot gas leaks over the bucket tip. This lowers stage sealing, reduces output, and raises tip temperature. Seal fin height is rejected on all 92 buckets.
- **Cutter teeth.** The cutter teeth cut a clean track in the shroud during running and set the tip clearance. Worn cutter teeth cannot hold the clearance, so tip leakage goes up. The cutter teeth are worn on all 92 buckets.
- **Z-notch and shroud interlock.** The Z-notch and shroud on each bucket lock to the next bucket. Together they form one continuous ring at the bucket tips. This ring stiffens the tips and controls bucket vibration and tip sealing. When the engagement is low, the ring is loose, the tip is less stiff, the bucket vibrates more, and the airfoil sees higher stress. On item 75 the engagement is below zero, which means the interlock contact is gone and that bucket no longer locks to its neighbor. The Z-notch is rejected on all 92 buckets, and engagement is below the 50% limit on 23 buckets.
- **Angel wings.** The angel wings seal the wheelspace below the airfoil and keep hot gas out of the rotor wheelspace. When the angel wing height is low, this seal is weak and hot gas can reach the wheelspace and the rotor. This raises rotor metal temperature. Angel wing height is rejected on all 92 buckets, and 4 buckets have cracks in this area.
- **Airfoil wall.** The airfoil wall carries the gas bending load and holds the cooling passages. Wall thickness gives the airfoil its creep strength and oxidation life. When the wall is thin, this margin drops. The thinnest readings are at the trailing edge concave, which is a high stress and high temperature area. Wall thickness is rejected on 10 buckets, with the thinnest at 0.62 mm.
- **Cracks.** A crack can grow under heat and load during running. Each crack must be removed and weld repaired before the bucket goes back in service. There are 5 cracks: one on a seal fin and four on angel wings.

These are the highest duty surfaces on the bucket. The loss is on every bucket and on more than one feature at the same time. Every bucket in the set was checked to confirm

that the base material can be saved and returned to service. The repair scope below restores each feature to its required condition.

8.2 Damage Assessment

- The damage is present on every bucket in the set and is concentrated on the critical control features: seal fin, cutter teeth, Z-notch, shroud interlock, angel wings, and airfoil.
- Three critical control dimensions are rejected across the full set: seal fin height, Z-notch, and angel wing height. Each is rejected on 92 of 92 buckets.
- The Z-notch shroud engagement is below the 50% limit on 23 of 92 buckets. The minimum engagement is -20.82% on item 75, which indicates complete loss of positive interlock contact at that bucket.
- Discrete crack indications are present on five buckets: seal fin on item 78, and angel wing on items 7, 28, 29, and 33.
- Wall thickness is rejected on 10 of 92 buckets, with the thinnest reading at 0.62 mm at the trailing edge concave region.
- The repair scope requires weld build up and machine and EDM restoration at multiple critical geometry features, plus a full coating strip and reapplication.
- The inspection and repair plan requires three heat treatment cycles, at least five FPI/NDT control points, dimensional and CMM verification, moment weighing, and a balance chart.
- The loss is full set and covers more than one critical feature on each bucket at the same time. It cannot be corrected by blending or by local repair. Each bucket needs weld reconstruction on more than one interface, plus full coating removal and reapplication.

8.3 Engineering Conclusion

The combined damage condition, the number of affected buckets, the number of affected critical locations, the full set rejection of three critical control dimensions, the loss of Z-notch engagement on a large group of buckets, the weld reconstruction requirement, the machine and EDM restoration requirement, the full coating strip and reapplication, the heat treatment cycles, the FPI/NDT cycles, and the final dimensional and moment verification confirm that the set requires HEAVY REPAIR: LEVEL 9 (SEVERE HEAVY REPAIR). The measured score is 22 of 22, which is the maximum of the Heavy Repair band.

8.4 Repair Recommendation

- Maintain serial number control for all 92 buckets throughout the repair process.
- Perform cleaning, chemical coating strip, incoming solution heat treatment, FPI/NDT, visual inspection, dimensional inspection, and metallurgical review as required.
- Remove defective material in repairable areas in preparation for weld repair.
- Perform weld build up and profile restoration on seal fin, cutter tooth, Z-notch, shroud, and angel wing areas, and restore Z-notch shroud engagement to within limit on the affected buckets.

- Excavate and weld repair the discrete cracks on items 7, 28, 29, 33, and 78.
- Use machine and EDM to recreate seal fin, cutter tooth, Z-notch, shroud, and angel wing geometry where required.
- Perform post weld solution heat treatment, reapply diffused MCrAlY coating, perform post coat heat treatment, and perform final age heat treatment.
- Perform repeated FPI/NDT, pulse thermography, and dimensional verification after repair and before final release.
- Perform moment weighing, balance chart preparation, blade location labeling, final visual inspection, and final report documentation.

9. Special Additional Repair Scope

Special Additional Repair Scope	Numeric Basis	Qty	Unit
Weld build up and restoration of seal fin and cutter tooth areas	Seal fin and cutter tooth fretage on 92 of 92 buckets; seal fin height rejected 92 of 92.	1	set
Weld build up and restoration of Z-notch and shroud areas	Z-notch fretage and rejection on 92 of 92 buckets.	1	set
Weld build up to restore Z-notch shroud engagement	23 of 92 buckets below the 50% engagement limit; minimum -20.82%.	1	set
Weld build up and restoration of angel wing areas	Angel wing fretage and deformation on 92 of 92 buckets; angel wing height rejected 92 of 92.	1	set
Crack excavation and weld repair	Discrete cracks on items 7, 28, 29, 33 (angel wing) and 78 (seal fin).	1	set
Machine and EDM to restore seal fin and cutter tooth configuration	Critical seal and cutter geometry restoration required.	1	set
EDM to recreate Z-notch and shroud profiles	Critical interface geometry restoration required.	1	set
Machine to recreate angel wing dimensions	Critical interface geometry restoration required.	1	set
Full coating strip and diffused MCrAlY reapplication	MCrAlY coating present as received; complete strip and recoat required.	1	set
Multiple FPI/NDT cycles and pulse thermography	At least five FPI/NDT control points plus post coat thermography.	1	set
Heat treatment cycles	Three cycles: incoming solution, post weld solution, and final age.	1	set
Dimensional and CMM verification	Incoming and post repair dimensional verification required.	1	set
Moment weighing and balance chart	Final moment weigh of all 92 buckets and balance chart required.	1	set

10. Technical Scope and Repair Burden

The table below lists the main blocks of work the set requires and why each block is needed. The work is full set and covers material, geometry, coating, heat treatment, and

inspection. Each block must be completed and verified before the set can return to service.

Work Block	Required Work for This Set	Why It Is Required
Material build up	Weld build up on the seal fin, cutter teeth, Z-notch, shroud, and angel wings on every bucket. Weld build up to restore Z-notch engagement on 23 buckets. Weld repair of 5 cracks.	These features are worn or rejected on the full set. They must be rebuilt with weld metal before the bucket can hold its sealing and engagement dimensions.
Geometry restoration	Machine and EDM to recreate the seal fin, cutter tooth, Z-notch, shroud, and angel wing shapes after weld build up.	The tip seal, the tip interlock, and the wheelspace seal all depend on correct shape. The geometry must be cut back to the design form.
Coating	Full chemical strip of the gas path coating, then diffused MCrAlY recoat, post coat heat treatment, and pulse thermography.	Weld repair cannot be done through the old coating. The coating is removed for repair, then reapplied to protect the airfoil for the next interval.
Heat treatment	Three heat treatment cycles: incoming solution, post weld solution, and final age.	Welding changes the metal. Heat treatment is needed to recover the alloy strength and relieve weld stress.
Inspection and balance	At least five FPI/NDT control points, pulse thermography, CMM and dimensional checks, moment weigh, and balance chart.	Each repair stage must pass inspection before the next. The full set must be moment matched and balanced before assembly.
Set control	Serial number control and blade location labeling for all 92 buckets, final report, and controlled packing.	The set runs as one turbine stage. Each bucket must be tracked, balanced, and placed in the correct position.

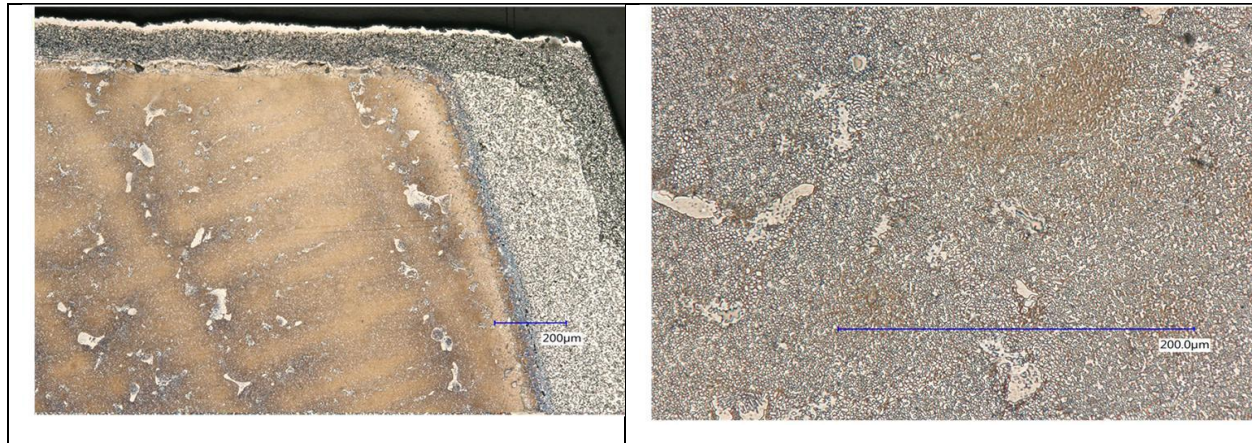
11. Material Evaluation Summary

Item	Result
Material confirmed	GTD 111
Coating type	MCrAlY (HVOF) coating, present as received
Hot gas path surface condition	Coated surface with surface fretting and corrosion; no substrate alloy depletion observed
Microstructure	Fine grain boundary carbide and a gamma matrix with fine gamma prime, primary carbide, and dispersed secondary carbide
Repairability recommendation	Base material considered suitable for repair following coating removal by acid stripping
Repair classification impact	Base material is repairable. The set can be saved and returned to service. The combined coating strip and recoat, weld build up, machine and EDM, repeated inspection, and heat treatment scope support Level 9 Heavy Repair.

Metallurgical sectioning

INCOMING INSPECTION REPORT

Reference		UNEW incoming metallurgical evaluation			Job order no.		1004061634		
Serial no. (or ID)		F2BH023737 (item 92)			Cutting location		Shroud		
Element	Co	Cr	Ni	Ti	W	Ta	Mo	Fe	Al
Nominal	9.5	14.0	Bal	4.9	3.8	2.8	-	-	4.0
Result	9.5	13.1	60.4	4.5	4.0	2.8	-	-	4.0



The cut section taken from bucket item 92 was mounted and evaluated to confirm whether the serviced component material remains acceptable for repair. The hot gas path surface was protected by MCrAlY (HVOF) coating. The base material was confirmed as GTD 111 alloy. Based on the evaluation, the base material remains acceptable for repair after removal of the coating by controlled acid stripping. The component is therefore repairable, subject to completion of the required Level 9 heavy repair scope, dimensional restoration, heat treatment, FPI/NDT verification, and final acceptance inspection. Microstructure micrographs are retained in the inspection file.

12. Final Classification

Classification Item	Disposition
Repair Classification	HEAVY REPAIR
Repair Level	LEVEL 9 (SEVERE HEAVY REPAIR), MAXIMUM OF THE HEAVY REPAIR BAND
Total Score Basis	22 of 22 points, with three Score 5 drivers
Primary Basis	Severe damage on every bucket in multiple critical areas, full set rejection of three critical control dimensions, loss of Z-notch shroud engagement on 23 buckets, multi feature weld and EDM reconstruction, full coating strip and recoat, three heat treatment cycles, and repeated FPI/NDT
Position Relative to Scale	Immediately below the Level 10 beyond economical repair and replacement threshold. Held at Level 9, and not above it, only by the confirmed repairability of the GTD 111 base material

Classification Item	Disposition
Repair Recommendation	Proceed with Level 9 heavy repair and final verification before release
Final Acceptance	Subject to successful repair, dimensional verification, FPI/NDT, heat treatment records, moment and balance verification, and final release documentation

Based on the incoming inspection findings, this set requires Heavy Repair at the maximum of the Heavy Repair band. This determination is the final technical position of UNEW for the Stage 2 bucket set. The classification reflects the measured condition of the parts only. For this set, UNEW will not apply a heavy repair charge to NSRP (see Section 19).

13. Z-notch Shroud Engagement Analysis

The Z-notch and shroud form a continuous interlocking ring at the bucket tip. The shroud engagement percentage measures how much of the design contact remains at the interlock. A reduced engagement reduces tip ring stiffness, increases bucket vibration, and increases tip gas path leakage. The minimum acceptable engagement is 50%. The incoming inspection recorded engagement below this limit on 23 of 92 buckets. The minimum recorded engagement is -20.82% on item 75, which indicates that the positive interlock contact has been lost at that bucket. Each of these buckets requires weld build up of the Z-notch contact point to restore engagement to within the required limit. The table below lists every bucket that is below the limit.

Item	Serial Number	Z-notch CC height (mm)	Z-notch CV height (mm)	Engagement (%)	Required Action
7	F2BH023857	275.89	274.87	44.54	Weld build up of Z-notch contact point to restore engagement within limit.
10	F2BH024233	275.83	274.94	28.24	Weld build up of Z-notch contact point to restore engagement within limit.
11	F2BN000461	276.53	275.10	21.62	Severe engagement loss. Weld build up to restore engagement within limit.
13	F2BH023852	275.64	274.89	40.00	Weld build up of Z-notch contact point to restore engagement within limit.
28	F2BH024234	275.90	274.97	7.35	Severe engagement loss. Weld build up to restore engagement within limit.
33	F2BH023885	275.95	274.82	47.46	Weld build up of Z-notch contact point to restore engagement within limit.
34	F2BH023729	275.84	274.96	37.50	Weld build up of Z-notch contact point to restore engagement within limit.

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Item	Serial Number	Z-notch CC height (mm)	Z-notch CV height (mm)	Engagement (%)	Required Action
36	F2BH023725	275.93	275.06	40.91	Weld build up of Z-notch contact point to restore engagement within limit.
38	F2BH024221	275.90	274.87	24.41	Severe engagement loss. Weld build up to restore engagement within limit.
42	F2BH023735	275.94	274.92	43.13	Weld build up of Z-notch contact point to restore engagement within limit.
50	F2BH023858	275.92	274.99	26.72	Weld build up of Z-notch contact point to restore engagement within limit.
51	F2BH023880	276.25	274.87	29.76	Weld build up of Z-notch contact point to restore engagement within limit.
56	F2BH024238	275.74	274.78	33.79	Weld build up of Z-notch contact point to restore engagement within limit.
57	F2BH024075	275.95	274.83	42.17	Weld build up of Z-notch contact point to restore engagement within limit.
59	F2BH023854	275.90	275.06	49.22	Weld build up of Z-notch contact point to restore engagement within limit.
63	F2BH023856	275.88	274.94	46.42	Weld build up of Z-notch contact point to restore engagement within limit.
66	F2BH023844	275.88	274.98	45.37	Weld build up of Z-notch contact point to restore

INCOMING INSPECTION REPORT

Item	Serial Number	Z-notch CC height (mm)	Z-notch CV height (mm)	Engagement (%)	Required Action
					engagement within limit.
68	F2BH024087	275.73	275.01	38.54	Weld build up of Z-notch contact point to restore engagement within limit.
72	F2BH023869	275.81	274.88	47.13	Weld build up of Z-notch contact point to restore engagement within limit.
73	F2BH023913	275.97	274.87	48.18	Weld build up of Z-notch contact point to restore engagement within limit.
75	F2BH023840	275.75	274.92	-20.82	Interlock contact lost. Weld build up to rebuild Z-notch contact point and restore engagement.
83	F2BH023861	275.93	274.92	49.18	Weld build up of Z-notch contact point to restore engagement within limit.
92	F2BH023737	276.04	275.09	28.62	Weld build up of Z-notch contact point to restore engagement within limit.

14. Wall Thickness Analysis

A full wall thickness inspection was performed on all 92 buckets. The airfoil wall was measured at twelve positions on each bucket, with four positions on the leading edge and eight positions on the trailing edge concave and convex sides. The inspection recorded wall thickness rejection against the position minimum wall limits on 10 of 92 buckets. The affected buckets are items 11, 13, 35, 55, 57, 65, 67, 72, 82, and 89. The thinnest readings recorded in the set were 0.62 mm and 0.65 mm, both at the trailing edge concave region, which is the thinnest wall region by design. The rejected buckets require blend or weld repair at the affected positions as dispositioned by engineering, with FPI verification of the airfoil pressure boundary. Complete wall thickness records for all 92 buckets are retained in the inspection file.

15. General Dimension Data

15.1 Airfoil and Platform Dimensions (A to G)

Item	A	B	C	D	E	F	G
1	286.44	56.13	29.69	30.23	47.73	2.32	36.98
2	286.45	56.25	29.79	30.45	47.40	2.25	36.82
3	286.42	56.12	29.75	30.57	47.27	2.24	36.90
4	286.43	56.12	29.66	30.38	47.29	2.33	36.90
5	286.46	56.17	29.73	30.38	47.72	2.32	37.01
6	286.41	56.20	29.75	30.52	47.51	2.30	36.91
7	286.48	56.28	29.73	30.33	47.48	2.27	36.97
8	286.46	56.08	29.65	30.29	47.27	2.30	36.85
9	286.46	56.07	29.76	30.35	47.39	2.29	37.05
10	286.45	56.06	29.69	30.26	47.60	2.25	36.83
11	286.43	56.19	29.78	30.45	47.55	2.80	36.92
12	286.44	56.15	29.79	30.82	47.44	2.69	36.89
13	286.49	56.15	29.77	30.46	47.33	2.24	36.98
14	286.46	56.16	29.74	30.48	47.43	2.24	36.82
15	286.54	56.06	29.73	30.34	47.46	2.27	36.89
16	286.51	56.15	29.77	30.47	47.48	2.37	36.95
17	286.47	56.13	29.73	30.43	47.54	2.38	36.92
18	286.49	56.16	29.73	30.58	47.96	2.28	36.80
19	286.51	56.23	29.78	30.48	47.91	2.35	36.96
20	286.46	56.13	29.69	30.38	47.90	2.35	36.93
21	286.47	56.23	29.79	30.43	47.75	2.34	36.94
22	286.51	56.19	29.73	30.34	47.64	2.32	36.96
23	286.49	56.16	29.73	30.50	47.68	2.30	36.92
24	286.48	56.18	29.76	30.57	47.84	2.33	36.95
25	286.49	56.18	29.73	30.38	47.66	2.45	36.91
26	286.51	56.12	29.71	30.61	47.71	2.34	36.97
27	286.45	55.97	29.58	30.35	47.84	2.18	36.96
28	286.47	56.10	29.71	30.41	47.81	2.42	36.87
29	286.46	56.12	29.78	30.51	47.91	2.99	36.88
30	286.48	56.18	29.70	30.37	47.65	2.37	36.91
31	286.45	56.07	29.71	30.45	47.78	2.28	36.89
32	286.48	56.12	29.75	30.55	47.86	2.27	36.91
33	286.51	56.26	29.80	30.52	47.59	2.34	36.85
34	286.46	56.39	29.79	30.42	47.89	2.31	36.95
35	286.48	56.17	29.71	30.65	47.79	2.89	36.81
36	286.52	56.29	29.75	30.41	47.71	2.33	36.88

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Item	A	B	C	D	E	F	G
37	286.55	56.13	29.73	30.52	47.82	2.98	36.87
38	286.51	56.17	29.71	30.45	47.79	2.29	36.95
39	286.53	56.10	29.73	30.41	47.66	2.70	36.89
40	286.52	56.18	29.75	30.43	47.75	2.31	36.94
41	286.50	56.17	29.73	30.41	47.78	2.28	36.93
42	286.52	56.11	29.70	30.45	47.71	2.31	36.93
43	286.54	56.06	29.68	30.43	47.64	2.75	36.82
44	286.43	56.01	29.67	30.56	47.85	2.37	36.92
45	286.49	56.21	29.79	30.40	47.80	2.33	36.87
46	286.46	56.12	29.78	30.41	47.82	2.04	37.08
47	286.48	56.17	29.76	30.38	47.79	2.38	36.92
48	286.47	56.20	29.79	30.36	47.75	2.49	36.86
49	286.49	56.12	29.70	30.59	47.81	2.38	36.87
50	286.49	56.33	29.74	30.29	47.83	2.32	36.92
51	286.51	56.27	29.73	30.36	47.71	2.30	36.87
52	286.53	56.17	29.75	30.57	47.64	2.42	36.91
53	286.46	56.09	29.73	30.39	47.77	2.28	36.95
54	286.49	56.18	29.72	30.33	47.63	2.24	36.86
55	286.47	56.14	29.75	30.37	47.74	2.23	36.94
56	286.49	56.16	29.78	30.32	47.82	2.37	36.90
57	286.52	56.12	29.74	30.54	47.75	2.37	36.82
58	286.53	56.15	29.73	30.57	47.73	2.29	36.93
59	286.52	56.07	29.70	30.47	47.82	2.26	36.84
60	286.52	56.19	29.84	30.55	48.09	2.31	37.01
61	286.47	56.18	29.68	30.62	47.90	2.26	36.89
62	286.51	56.14	29.74	30.31	47.65	2.42	36.90
63	286.50	56.15	29.69	30.48	47.77	2.30	36.88
64	286.46	56.26	29.75	30.39	47.75	2.16	36.87
65	286.50	56.22	29.74	30.39	47.68	2.35	37.07
66	286.51	56.15	29.77	30.28	47.66	2.22	36.91
67	286.50	56.23	29.79	30.40	47.84	2.40	36.73
68	286.47	56.08	29.66	30.33	47.61	2.26	36.94
69	286.57	56.10	29.72	30.62	47.70	2.79	36.91
70	286.48	56.12	29.68	30.44	47.95	2.07	36.93
71	286.52	56.10	29.72	30.39	47.76	2.16	36.90
72	286.49	56.19	29.79	30.43	47.81	2.25	36.95
73	286.44	56.08	29.75	30.29	47.75	2.29	36.90
74	286.46	56.10	29.62	30.40	47.88	2.77	36.83

INCOMING INSPECTION REPORT

Item	A	B	C	D	E	F	G
75	286.48	56.15	29.76	30.56	47.76	2.20	36.95
76	286.45	56.13	29.79	30.51	47.71	2.74	36.85
77	286.46	56.28	29.80	30.39	47.70	2.38	36.92
78	286.53	56.12	29.72	30.30	47.80	2.34	36.91
79	286.46	56.06	29.81	30.53	47.84	2.33	36.84
80	286.48	56.08	29.70	30.32	47.69	2.20	36.83
81	286.48	56.22	29.69	30.52	47.91	2.30	36.91
82	286.45	56.22	29.69	30.33	47.70	2.29	36.90
83	286.47	56.11	29.70	30.44	47.67	2.34	36.85
84	286.48	56.22	29.73	30.38	47.73	2.30	36.91
85	286.41	56.00	29.61	30.40	47.83	2.09	36.92
86	286.45	56.19	29.74	30.36	47.75	2.32	36.94
87	286.47	56.21	29.71	30.40	47.82	2.19	36.95
88	286.41	56.10	29.70	30.49	47.73	2.32	36.86
89	286.42	56.14	29.71	30.50	47.77	2.39	36.89
90	286.45	56.18	29.66	30.43	47.82	2.10	36.97
91	286.38	56.14	29.72	30.42	47.98	2.45	36.94
92	286.47	56.14	29.71	30.40	47.73	2.25	36.88

15.2 Z-notch Shroud and Engagement Dimensions

Engagement values below the 50% limit are highlighted.

Item	Z-notch CC shroud height (mm)	Z-notch CV shroud height (mm)	Concave Z-notch thickness (mm)	Convex Z-notch thickness (mm)	Shroud Engagement (%)
1	275.82	274.89	1.68	2.05	55.88
2	275.80	275.15	1.97	1.96	68.93
3	275.76	275.05	1.72	1.73	63.32
4	275.69	274.83	2.14	2.19	54.05
5	275.83	274.97	1.79	2.15	55.20
6	275.93	275.04	1.89	2.35	63.50
7	275.89	274.87	2.18	2.15	44.54
8	276.06	275.01	1.89	2.10	58.49
9	275.88	274.90	1.52	2.03	54.47
10	275.83	274.94	1.89	2.22	28.24
11	276.53	275.10	1.41	2.11	21.62
12	276.75	275.24	1.61	2.71	85.32
13	275.64	274.89	2.09	2.10	40.00
14	276.15	275.03	1.60	2.21	67.45
15	275.75	274.92	1.83	2.34	54.65

INCOMING INSPECTION REPORT

Item	Z-notch CC shroud height (mm)	Z-notch CV shroud height (mm)	Concave Z- notch thickness (mm)	Convex Z- notch thickness (mm)	Shroud Engagement (%)
16	275.98	274.88	1.42	2.40	62.00
17	275.79	274.91	1.95	2.06	54.34
18	275.85	274.95	2.20	2.25	67.01
19	275.69	274.96	1.73	2.30	68.66
20	275.68	274.99	1.95	2.04	60.26
21	275.80	274.92	1.91	2.49	59.27
22	275.93	274.89	1.91	2.70	63.01
23	275.89	274.95	1.70	2.11	64.20
24	275.70	274.84	2.46	2.50	69.45
25	275.60	275.02	1.91	1.98	64.69
26	275.72	274.99	1.84	2.35	64.21
27	275.83	275.11	1.76	2.20	63.73
28	275.90	274.97	2.00	1.96	7.35
29	276.79	275.20	1.50	2.49	73.54
30	275.86	274.91	1.51	2.13	68.61
31	275.58	274.93	1.88	2.00	52.38
32	275.88	275.03	2.12	2.28	59.43
33	275.95	274.82	1.89	1.93	47.46
34	275.84	274.96	2.14	2.36	37.50
35	276.44	274.98	1.72	2.47	61.56
36	275.93	275.06	2.03	2.39	40.91
37	276.47	275.03	1.78	2.58	66.30
38	275.90	274.87	1.75	2.06	24.41
39	276.42	275.21	1.50	2.61	78.47
40	275.77	275.18	2.43	2.07	55.75
41	276.09	275.02	1.91	1.93	52.18
42	275.94	274.92	1.96	2.45	43.13
43	276.31	275.05	1.85	2.11	63.99
44	275.81	274.98	2.43	2.38	57.04
45	276.00	275.00	1.47	1.70	56.42
46	275.74	274.91	2.02	2.40	55.87
47	275.97	275.20	1.60	1.73	55.86
48	275.97	274.88	1.86	2.33	56.03
49	275.91	275.02	1.98	2.03	55.79
50	275.92	274.99	2.08	1.71	26.72
51	276.25	274.87	1.34	1.95	29.76

INCOMING INSPECTION REPORT

Item	Z-notch CC shroud height (mm)	Z-notch CV shroud height (mm)	Concave Z- notch thickness (mm)	Convex Z- notch thickness (mm)	Shroud Engagement (%)
52	276.24	274.95	1.58	2.57	59.00
53	276.00	274.92	1.68	2.03	58.05
54	275.77	275.08	2.16	2.26	62.81
55	275.92	274.98	1.63	2.07	63.33
56	275.74	274.78	2.06	1.77	33.79
57	275.95	274.83	2.28	2.03	42.17
58	276.00	274.91	2.04	2.15	53.49
59	275.90	275.06	2.18	2.04	49.22
60	276.10	275.02	2.02	2.15	68.30
61	275.70	274.93	2.07	2.31	57.23
62	275.92	274.97	2.37	2.33	61.00
63	275.88	274.94	1.94	1.86	46.42
64	275.93	275.00	1.99	1.81	52.02
65	275.87	274.98	2.22	2.19	58.80
66	275.88	274.98	2.32	2.28	45.37
67	276.22	275.19	1.82	1.97	72.54
68	275.73	275.01	1.83	2.25	38.54
69	276.40	275.15	1.84	2.58	69.62
70	275.93	275.18	1.74	2.01	79.11
71	275.59	274.99	2.08	2.01	59.41
72	275.81	274.88	2.11	2.05	47.13
73	275.97	274.87	1.52	2.14	48.18
74	275.98	275.07	1.93	2.38	71.13
75	275.75	274.92	2.31	1.43	-20.82
76	276.65	274.95	1.85	2.50	61.04
77	275.93	275.08	1.49	2.42	61.86
78	276.00	274.92	1.62	2.19	61.15
79	275.77	275.07	2.08	2.15	75.00
80	275.60	275.22	2.20	1.81	56.83
81	276.00	275.04	1.76	2.18	67.74
82	275.74	274.95	2.06	2.04	52.13
83	275.93	274.92	2.07	2.06	49.18
84	275.97	274.99	2.13	2.02	63.19
85	275.74	275.10	1.75	1.90	54.34
86	275.97	274.89	2.20	2.18	53.89
87	275.90	274.95	1.59	2.03	56.70

INCOMING INSPECTION REPORT

Item	Z-notch CC shroud height (mm)	Z-notch CV shroud height (mm)	Concave Z-notch thickness (mm)	Convex Z-notch thickness (mm)	Shroud Engagement (%)
88	275.83	275.26	1.92	2.19	61.48
89	276.10	275.27	1.46	1.80	77.27
90	275.68	274.93	2.19	2.38	58.56
91	275.92	275.07	2.04	2.17	55.08
92	276.04	275.09	1.83	2.38	28.62

16. Defect Legend Table

The table records the dimensional disposition of each bucket against the critical control features, and the repair method that applies. ACC means acceptable as is. REJ means the dimension is unacceptable and requires repair. The repair method codes are defined in the key below the table.

Item	Seal Fin Height	Z-notch	Z-notch Engagement	Angel Wing Height	Wall Thickness	Repair Method
1	REJ	REJ	ACC	REJ	ACC	B / WB / WM
2	REJ	REJ	ACC	REJ	ACC	B / WB / WM
3	REJ	REJ	ACC	REJ	ACC	B / WB / WM
4	REJ	REJ	ACC	REJ	ACC	B / WB / WM
5	REJ	REJ	ACC	REJ	ACC	B / WB / WM
6	REJ	REJ	ACC	REJ	ACC	B / WB / WM
7	REJ	REJ	REJ	REJ	ACC	B / WB / WM *
8	REJ	REJ	ACC	REJ	ACC	B / WB / WM
9	REJ	REJ	ACC	REJ	ACC	B / WB / WM
10	REJ	REJ	REJ	REJ	ACC	B / WB / WM
11	REJ	REJ	REJ	REJ	REJ	B / WB / WM
12	REJ	REJ	ACC	REJ	ACC	B / WB / WM
13	REJ	REJ	REJ	REJ	REJ	B / WB / WM
14	REJ	REJ	ACC	REJ	ACC	B / WB / WM
15	REJ	REJ	ACC	REJ	ACC	B / WB / WM
16	REJ	REJ	ACC	REJ	ACC	B / WB / WM
17	REJ	REJ	ACC	REJ	ACC	B / WB / WM
18	REJ	REJ	ACC	REJ	ACC	B / WB / WM
19	REJ	REJ	ACC	REJ	ACC	B / WB / WM
20	REJ	REJ	ACC	REJ	ACC	B / WB / WM
21	REJ	REJ	ACC	REJ	ACC	B / WB / WM
22	REJ	REJ	ACC	REJ	ACC	B / WB / WM
23	REJ	REJ	ACC	REJ	ACC	B / WB / WM
24	REJ	REJ	ACC	REJ	ACC	B / WB / WM
25	REJ	REJ	ACC	REJ	ACC	B / WB / WM
26	REJ	REJ	ACC	REJ	ACC	B / WB / WM
27	REJ	REJ	ACC	REJ	ACC	B / WB / WM
28	REJ	REJ	REJ	REJ	ACC	B / WB / WM *
29	REJ	REJ	ACC	REJ	ACC	B / WB / WM *
30	REJ	REJ	ACC	REJ	ACC	B / WB / WM
31	REJ	REJ	ACC	REJ	ACC	B / WB / WM
32	REJ	REJ	ACC	REJ	ACC	B / WB / WM

INCOMING INSPECTION REPORT

Item	Seal Fin Height	Z-notch	Z-notch Engagement	Angel Wing Height	Wall Thickness	Repair Method
33	REJ	REJ	REJ	REJ	ACC	B / WB / WM *
34	REJ	REJ	REJ	REJ	ACC	B / WB / WM
35	REJ	REJ	ACC	REJ	REJ	B / WB / WM
36	REJ	REJ	REJ	REJ	ACC	B / WB / WM
37	REJ	REJ	ACC	REJ	ACC	B / WB / WM
38	REJ	REJ	REJ	REJ	ACC	B / WB / WM
39	REJ	REJ	ACC	REJ	ACC	B / WB / WM
40	REJ	REJ	ACC	REJ	ACC	B / WB / WM
41	REJ	REJ	ACC	REJ	ACC	B / WB / WM
42	REJ	REJ	REJ	REJ	ACC	B / WB / WM
43	REJ	REJ	ACC	REJ	ACC	B / WB / WM
44	REJ	REJ	ACC	REJ	ACC	B / WB / WM
45	REJ	REJ	ACC	REJ	ACC	B / WB / WM
46	REJ	REJ	ACC	REJ	ACC	B / WB / WM
47	REJ	REJ	ACC	REJ	ACC	B / WB / WM
48	REJ	REJ	ACC	REJ	ACC	B / WB / WM
49	REJ	REJ	ACC	REJ	ACC	B / WB / WM
50	REJ	REJ	REJ	REJ	ACC	B / WB / WM
51	REJ	REJ	REJ	REJ	ACC	B / WB / WM
52	REJ	REJ	ACC	REJ	ACC	B / WB / WM
53	REJ	REJ	ACC	REJ	ACC	B / WB / WM
54	REJ	REJ	ACC	REJ	ACC	B / WB / WM
55	REJ	REJ	ACC	REJ	REJ	B / WB / WM
56	REJ	REJ	REJ	REJ	ACC	B / WB / WM
57	REJ	REJ	REJ	REJ	REJ	B / WB / WM
58	REJ	REJ	ACC	REJ	ACC	B / WB / WM
59	REJ	REJ	REJ	REJ	ACC	B / WB / WM
60	REJ	REJ	ACC	REJ	ACC	B / WB / WM
61	REJ	REJ	ACC	REJ	ACC	B / WB / WM
62	REJ	REJ	ACC	REJ	ACC	B / WB / WM
63	REJ	REJ	REJ	REJ	ACC	B / WB / WM
64	REJ	REJ	ACC	REJ	ACC	B / WB / WM
65	REJ	REJ	ACC	REJ	REJ	B / WB / WM
66	REJ	REJ	REJ	REJ	ACC	B / WB / WM
67	REJ	REJ	ACC	REJ	REJ	B / WB / WM
68	REJ	REJ	REJ	REJ	ACC	B / WB / WM
69	REJ	REJ	ACC	REJ	ACC	B / WB / WM

INCOMING INSPECTION REPORT

Item	Seal Fin Height	Z-notch	Z-notch Engagement	Angel Wing Height	Wall Thickness	Repair Method
70	REJ	REJ	ACC	REJ	ACC	B / WB / WM
71	REJ	REJ	ACC	REJ	ACC	B / WB / WM
72	REJ	REJ	REJ	REJ	REJ	B / WB / WM
73	REJ	REJ	REJ	REJ	ACC	B / WB / WM
74	REJ	REJ	ACC	REJ	ACC	B / WB / WM
75	REJ	REJ	REJ	REJ	ACC	B / WB / WM
76	REJ	REJ	ACC	REJ	ACC	B / WB / WM
77	REJ	REJ	ACC	REJ	ACC	B / WB / WM
78	REJ	REJ	ACC	REJ	ACC	B / WB / WM *
79	REJ	REJ	ACC	REJ	ACC	B / WB / WM
80	REJ	REJ	ACC	REJ	ACC	B / WB / WM
81	REJ	REJ	ACC	REJ	ACC	B / WB / WM
82	REJ	REJ	ACC	REJ	REJ	B / WB / WM
83	REJ	REJ	REJ	REJ	ACC	B / WB / WM
84	REJ	REJ	ACC	REJ	ACC	B / WB / WM
85	REJ	REJ	ACC	REJ	ACC	B / WB / WM
86	REJ	REJ	ACC	REJ	ACC	B / WB / WM
87	REJ	REJ	ACC	REJ	ACC	B / WB / WM
88	REJ	REJ	ACC	REJ	ACC	B / WB / WM
89	REJ	REJ	ACC	REJ	REJ	B / WB / WM
90	REJ	REJ	ACC	REJ	ACC	B / WB / WM
91	REJ	REJ	ACC	REJ	ACC	B / WB / WM
92	REJ	REJ	REJ	REJ	ACC	B / WB / WM

* Buckets with a discrete crack indication (items 7, 28, 29, 33, and 78) additionally require crack excavation and weld repair at the affected feature.

Key: **B** = Blend repair within the location blend limits. **WB** = Weld and Blend within the area limits. **WM** = Weld and Machining to build material and restore original dimensions and contours. **WE** = Welding and EDM to build material and restore original dimensions. **ACC** = Acceptable as is. **REJ** = Dimension unacceptable and requires repair.

17. Serial Number Correlation

Incoming inspection part number correlation sheet. This sheet is not to be used for blade assembly or positioning. Reference the final inspection report moment weigh report for position during assembly.

Item	Serial Number	Item	Serial Number
1	F2BH023881	47	F2BH024149
2	F2BH023734	48	F2BH023714
3	F2BH023860	49	F2BH024124
4	F2BH024236	50	F2BH023858
5	F2BH023715	51	F2BH023880
6	F2BH023733	52	F2BH023694
7	F2BH023857	53	F2BH023870
8	F2BH024237	54	F2BH023732
9	F2BH023936	55	F2BH023801
10	F2BH024233	56	F2BH024238
11	F2BN000461	57	F2BH024075
12	F2BN001174	58	F2BH023886
13	F2BH023852	59	F2BH023854
14	F2BH023736	60	F2BH023859
15	F2BH023928	61	F2BH023824
16	F2BH023726	62	F2BH023931
17	F2BH023553	63	F2BH023856
18	F2BH023871	64	F2BH023759
19	F2BH023315	65	F2BH023862
20	F2BH024226	66	F2BH023844
21	F2BH023728	67	F2BH024131
22	F2BH023739	68	F2BH024087
23	F2BH023347	69	F2BN001146
24	F2BH023727	70	F2BH023795
25	F2BH023024	71	F2BH023839
26	F2BH023738	72	F2BH023869
27	F2BH021791	73	F2BH023913
28	F2BH024234	74	F2BN000859
29	F2BN001176	75	F2BH023840
30	F2BH024235	76	F2BN000873
31	F2BH024241	77	F2BH022798
32	F2BH024223	78	F2BH024232
33	F2BH023885	79	F2BH024217
34	F2BH023729	80	F2BH024220

INCOMING INSPECTION REPORT

Item	Serial Number	Item	Serial Number
35	F2BN000783	81	F2BH023826
36	F2BH023725	82	F2BH023868
37	F2BN001091	83	F2BH023861
38	F2BH024221	84	F2BH023887
39	F2BN000864	85	F2BH023855
40	F2BH024224	86	F2BH023879
41	F2BH023865	87	F2BH023796
42	F2BH023735	88	F2BH024222
43	F2BN000867	89	F2BH024135
44	F2BH023730	90	F2BH023843
45	F2BH023878	91	F2BH023036
46	F2BH023841	92	F2BH023737

18. Photographic Record

Photographs of the as received and post inspection condition were taken during the incoming inspection. The documented conditions are indexed below. The photographs are retained in the inspection file and accompany the issued report.

Figure	Documented Condition
1	As received condition of the bucket set (multiple views)
2	Bucket condition after incoming cleaning and inspection (multiple views)
3	Frettage on seal fin
4	Frettage on cutter teeth
5	Crack on seal fin (item 78)
6	Frettage on Z-notch
7	Weldment and contact wear on Z-notch
8	Deformation and frettage on angel wing
9	Foreign object damage on angel wing
10	Crack on angel wing (items 7, 28, 29, 33)
11	Weldment on angel wing
12	Metallurgical sectioning location on shroud (item 92)



Figure 1. As-received condition.



Figure 2. As-received condition.



Figure 3. As-received condition.



Figure 4. As-received condition.



Figure 5. As-received condition.



Figure 6. As-received condition.

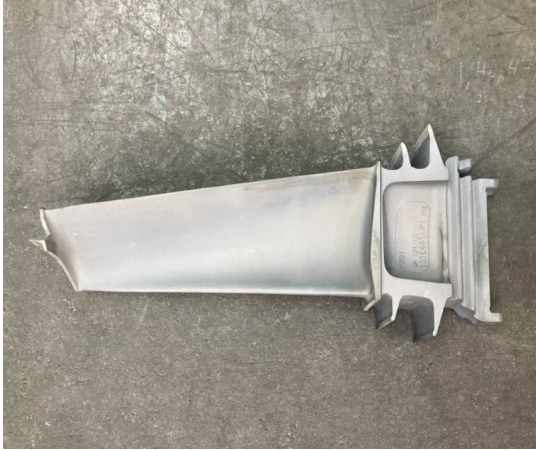


Figure 7. Condition after incoming inspection.



Figure 8. Condition after incoming inspection.



Figure 9. Condition after incoming inspection.



Figure 10. Condition after incoming inspection.



Figure 11. Condition after incoming inspection.



Figure 12. Condition after incoming inspection.

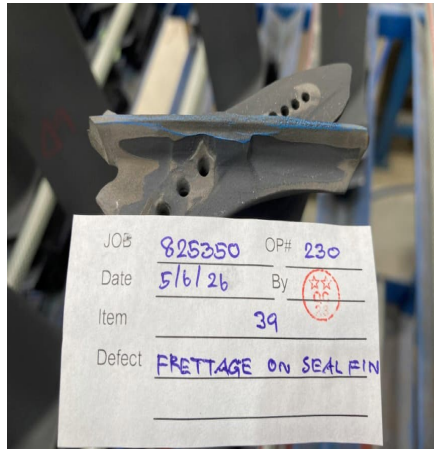


Figure 13. Fretage on seal fin.



Figure 14. Fretage on seal fin.



Figure 15. Fretage on Z-notch.



Figure 16. Weldment on Z-notch.

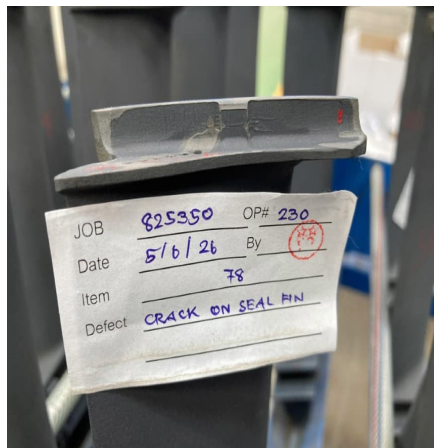


Figure 17. Crack on seal fin.



Figure 18. Fretage on cutter teeth.



Figure 19. Deformation and fretage on angel wing.

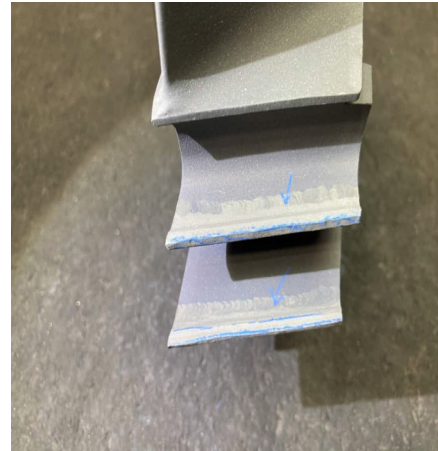


Figure 20. FOD on angel wing.



Figure 21. Deformation on angel wing.

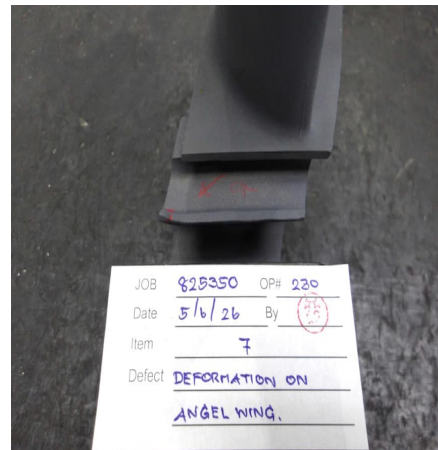


Figure 22. Deformation and crack on angel wing.

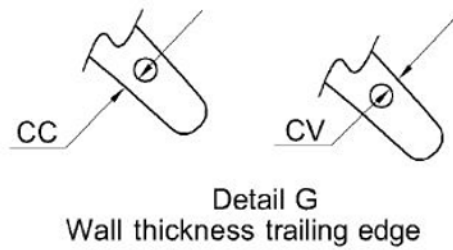
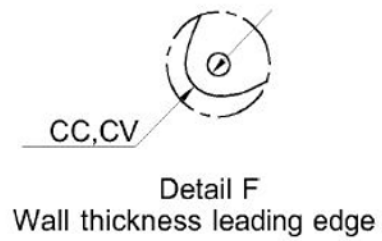
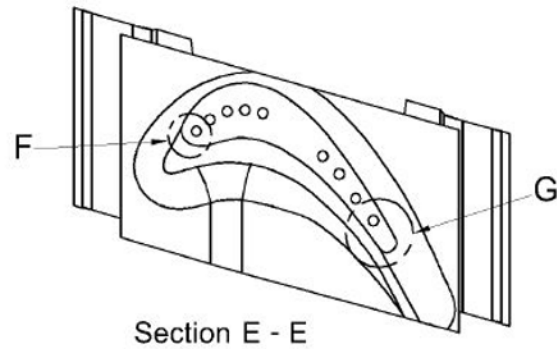
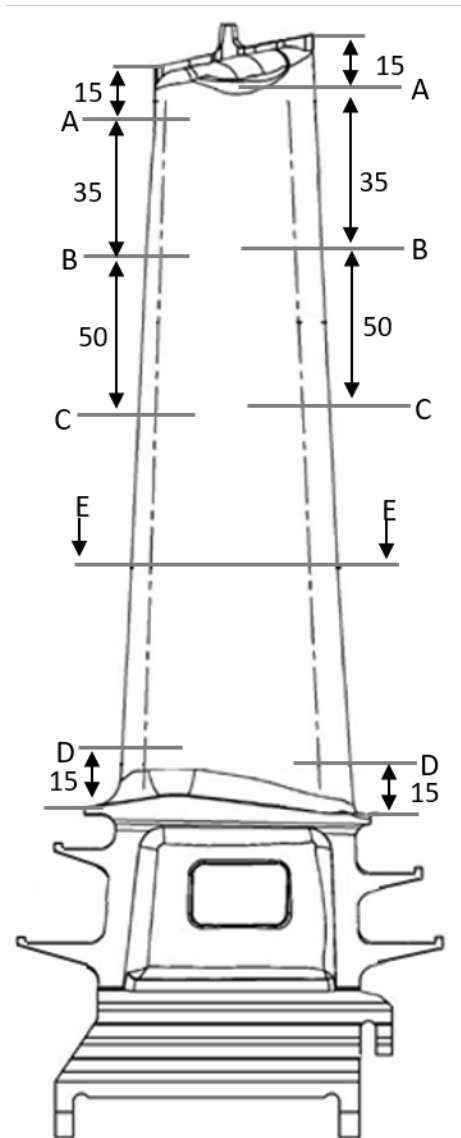


Figure 23. Crack on angel wing.

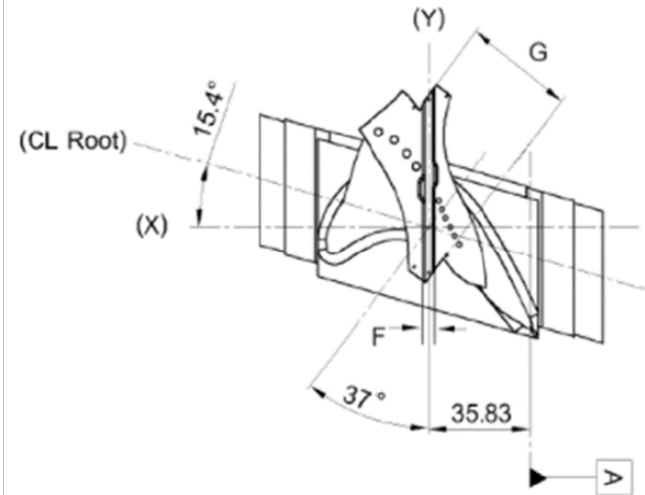
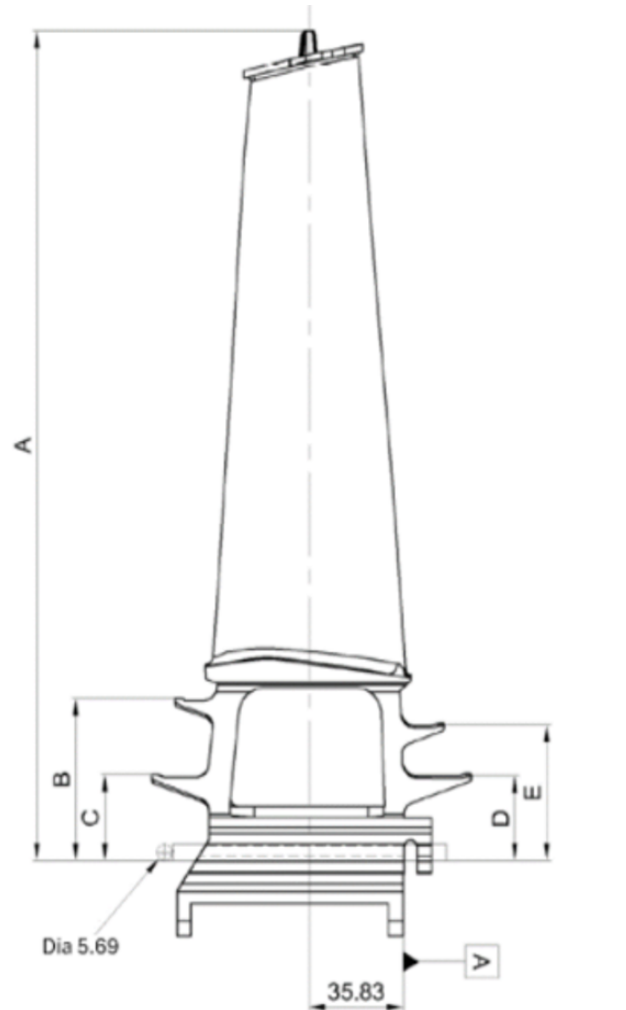


Figure 24. Weldment on angel wing.

19.0 THICKNESS RESULTS



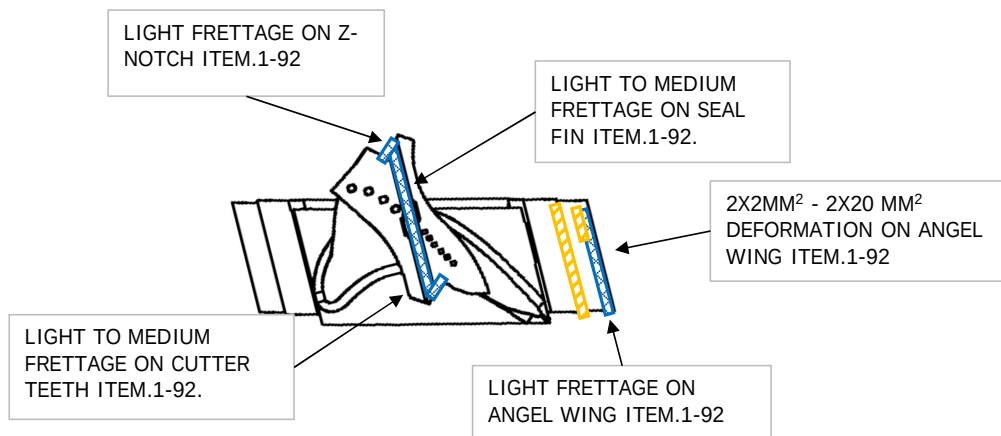
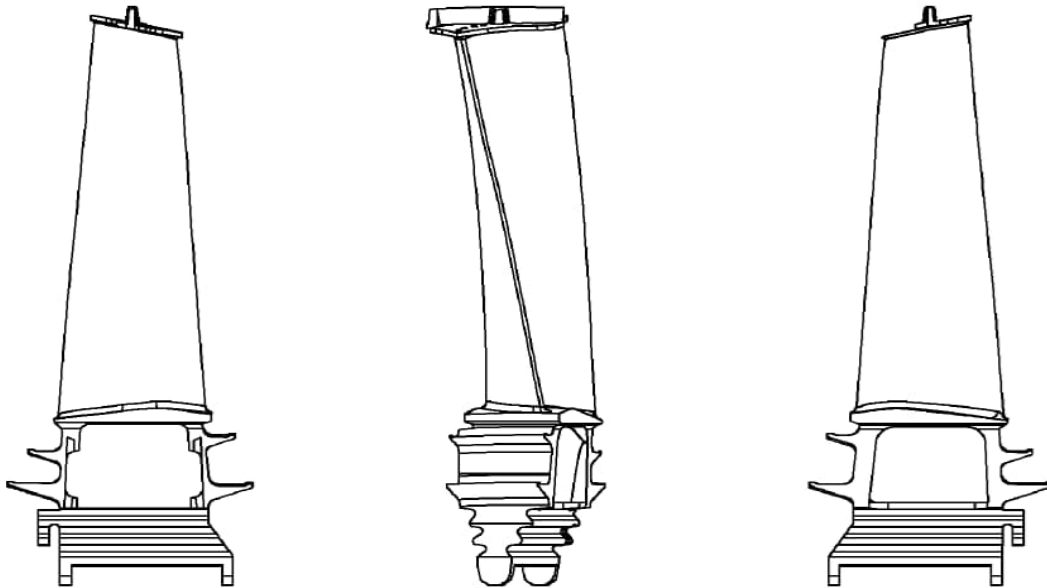
20.0 GENERAL DIMENSION



21.0 DEFECT MAP

INSPECTION AND PROCESS RECORD SHEET	MS6001FA 2nd STAGE BUCKET	IPRS NO.	3066-40
	PART NUMBER : GEBL02M6FA	REV.	00
CUSTOMER :	Nghi Son Refinery &	CUSTOMER PO :	WO-1004061634-100406
JOB NUMBER :	825350	OP.	230
INSPECTED BY :	Mr.Promarin srisapum	DATE :	06/05/2026

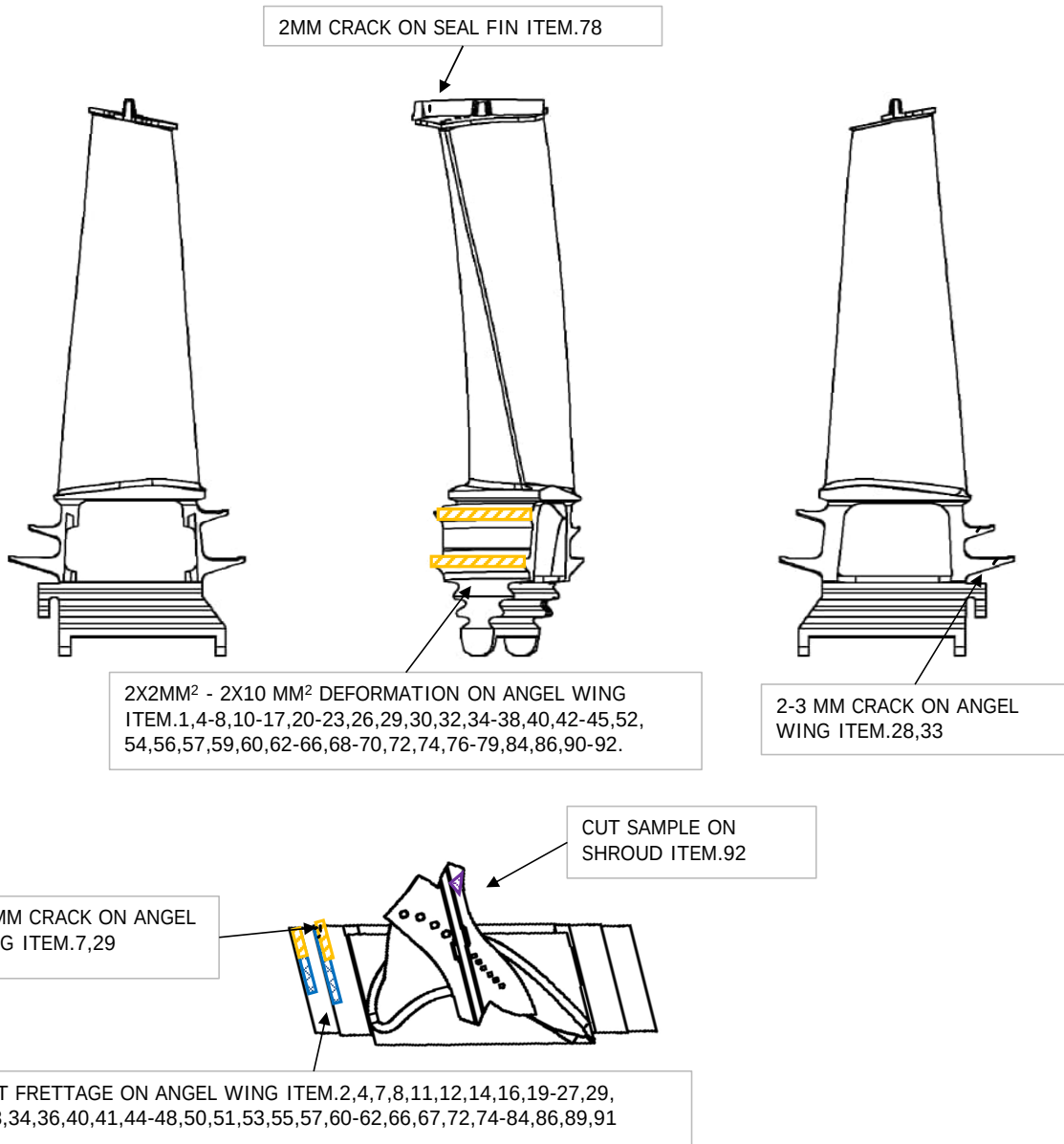
Crack (mm)
 Foreign Object Damage (L/M/H)
 Fretting (L/M/H)
 Deformation area(mm²)
 Corrosion (L/M/H)
 Missing Material (mm²)



13.0 DEFECT MAP (CONTINUE)

INSPECTION AND PROCESS RECORD SHEET	MS6001FA 2nd STAGE BUCKET	IPRS NO.	3066-40
	PART NUMBER : GEBL02M6FA	REV.	00
CUSTOMER :	Nghi Son Refinery	CUSTOMER PO :	WO-1004061634-1004061642-HGP-FN
JOB NUMBER :	825350	OP.	230
INSPECTED BY :	Mr.Promarin srisapum	DATE :	06/05/2026

Crack (mm)
 Foreign Object Damage (L/M/H)
 Fretage (L/M/H)
 Deformation area(mm²)
 Corrosion (L/M/H)
 Missing Material (mm²)



22. UNEW Position and Recommendation to NSRP

Why this report took longer than usual

- This bucket set arrived severely damaged. Every bucket was worn or damaged on several critical features at the same time.
- The measured condition placed the set at the top of the repairable range. It was one step away from scrap and replacement.
- At most repair shops, a set in this condition is condemned and the customer is told to scrap it.
- UNEW chose to save the set instead. We prepared a special recovery plan for it.
- We held the recovery plan and this report for review and approval by our engineering department before release. **This engineering review is the reason for the delay.**

UNEW is not charging heavy repair

- **UNEW will not charge NSRP a heavy repair price for this set.**
- UNEW does not classify parts as heavy repair to charge more. The Level 9 classification reports the true condition of the parts only.
- Our goal is to save these parts and to protect the reliability of the NSRP power plant.
- UNEW takes responsibility for the reliable operation of your generators. We are absorbing the extra restoration and coating work needed to bring this set back to service.

What UNEW is doing to save this set

- Full dimensional restoration of the seal fin, cutter teeth, Z-notch, shroud, and angel wings, by weld build up, machining, and EDM, then CMM check, moment weighing, and balancing. This is the largest part of the work.
- Full removal of the old coating, then a new special high temperature coating to protect the airfoils for the next service interval.
- Many NDT checks (at least five FPI and NDT points, plus thermography), so every step is verified before the set moves forward.
- The GTD 111 base material was sectioned and found sound. This is the only reason the set can be repaired instead of scrapped.

How NSRP and UNEW can avoid heavy repair in the future

- **Inspect early, while repairs are still light.** A worn seal fin, Z-notch, or angel wing caught early needs only a light blend or weld. Left to run, the same feature wears past the repair limit and the part is scrapped. Early inspection keeps parts repairable; late inspection loses them.
- UNEW can advise on operating and inspection intervals that reduce wear on the critical features (seal fin, Z-notch, angel wing).
- UNEW can supply improved and upgraded parts that last longer and run more efficiently.

- Working together, we can raise generator efficiency, lower repair cost over time, and extend the life of the parts.
- **The goal is simple: fewer heavy repairs, more reliable units, and lower total cost for NSRP.**

UNEW final position

- This report and its Level 9 classification are the final engineering position of UNEW, after internal review and approval. The classification records the condition of the parts; the decision not to charge heavy repair is UNEW's commitment to the reliability of the NSRP plant.

ANNEX A - QUANTIFIED HEAVY REPAIR WORK SCOPE

2ND STAGE BUCKET

Annex to Incoming Inspection Report, WO-1004061634 to WO-1004061642

Customer	Nghi Son Refinery & Petrochemical LLC	Report Date	27 April 2026
Customer P.O. No.	WO-1004061634 to WO-1004061642	UNEW Work Order	825350
Engine Type	MS6001FA (GE Frame 6FA)	Component	2nd Stage Bucket
Component Part No.	131E4411 P1H1	Qty. Received	92 pieces (1 complete set)
Repair Classification	HEAVY REPAIR	UNEW Repair Severity	Level 9 (Severe), ceiling of the repairable range

A1. PURPOSE AND SCOPE

This Annex records the work quantity of the repair route required by the recorded incoming condition of this set: how many times each process is performed, at which feature, on how many units, and against which recorded finding.

The repair classification of this set is HEAVY REPAIR, UNEW Repair Severity Level 9 (Severe), ceiling of the repairable range, as recorded in the incoming inspection report. All quantities in this Annex are taken from the recorded findings, dimensional results, per item dispositions and part quantities of that report. One controlled operation is one process action applied at one feature location on one bucket, or to the complete set where the process is a set level process.

A2. COMPONENT FEATURE COUNT

A process step is one line of the repair route, but it is not one job: it is performed at every affected feature on every bucket. The feature counts below establish the multiplier applied throughout this Annex.

Feature	Per bucket	Complete set	Source in the incoming inspection report
Bucket	1	92	Section 17, serial correlation, 92 buckets received
Seal fin	1	92	Section 9, seal fin fretting and height rejection on 92 of 92

ANNEX A - QUANTIFIED HEAVY REPAIR WORK SCOPE

Feature	Per bucket	Complete set	Source in the incoming inspection report
Cutter tooth area	1	92	Section 9, cutter tooth frettage on 92 of 92
Z notch and shroud	1	92	Section 9, Z notch frettage and rejection on 92 of 92
Angel wing	1	92	Section 9, angel wing frettage and deformation on 92 of 92
Critical feature groups requiring weld build up	5	460	Section 10, material build up work block, five features on every bucket

A3. RECORDED FINDINGS AND REQUIRED RESTORATION

Finding	Recorded extent	Restoration required	Locations
Seal fin and cutter tooth areas	Frettage on 92 of 92 buckets; seal fin height rejected 92 of 92	Weld build up and restoration	92
Z notch and shroud areas	Z notch frettage and rejection on 92 of 92 buckets	Weld build up and restoration	92
Angel wing areas	Frettage and deformation on 92 of 92; angel wing height rejected 92 of 92	Weld build up and restoration	92
Z notch shroud engagement	23 of 92 buckets below the 50 percent engagement limit, minimum minus 20.82 percent	Weld build up to restore engagement	23
Discrete cracks	Angel wing Items 7, 28, 29 and 33; seal fin Item 78	Crack excavation and weld repair	5
Airfoil wall thickness	Wall thickness dispositions required	Blend or weld repair per engineering disposition	10
TOTAL WELD BUILD UP AND WELD REPAIR LOCATIONS			314

ANNEX A - QUANTIFIED HEAVY REPAIR WORK SCOPE

A4. DIMENSIONAL REJECTIONS AND GEOMETRY RESTORATION

The features below are recorded as REJECT or out of limit against fixed acceptance criteria. Each requires physical restoration, not measurement.

Feature	Recorded result	Restoration required	Ops.
Seal fin height	REJECT on 92 of 92 buckets	Machine and EDM to restore seal fin and cutter tooth configuration	92
Z notch and shroud profile	REJECT on 92 of 92 buckets	EDM to recreate Z notch and shroud profiles	92
Angel wing height	REJECT on 92 of 92 buckets	Machine to recreate angel wing dimensions	92
Z notch shroud engagement	23 of 92 below the 50 percent limit, minimum minus 20.82 percent	Engagement restored by weld build up and re cut to profile	23
TOTAL GEOMETRY RESTORATION OPERATIONS			299

A5. REPAIR ROUTE WITH WORK QUANTITY

Step	Process, applies to all 92 buckets	Work quantity across the set	Ops.
1	Receipt inspection and serial number recording	92 buckets under serial control	92
1a	Incoming visual inspection	92 buckets	92
2	Incoming dimensional and CMM verification	92 dimensional inspections and 92 CMM verifications	184
3	Wall thickness measurement	92 buckets	92
4	Z notch shroud engagement measurement	92 buckets	92
5	Full chemical strip of the gas path diffused MCrAlY coating	92 buckets	92
6	Incoming fluorescent penetrant inspection, control point 1	92 buckets	92

ANNEX A - QUANTIFIED HEAVY REPAIR WORK SCOPE

Step	Process, applies to all 92 buckets	Work quantity across the set	Ops.
7	Incoming solution heat treatment	92 furnace exposures, cycle 1 of 3	92
8	Defect preparation and blending to sound metal at the critical features	5 feature groups on every bucket, 460 preparations	460
9	FPI after defect preparation, control point 2	92 buckets	92
10	Weld build up and restoration of the seal fin and cutter tooth areas	92 buckets	92
11	Weld build up and restoration of the Z notch and shroud areas	92 buckets	92
12	Weld build up and restoration of the angel wing areas	92 buckets	92
13	Weld build up to restore Z notch shroud engagement	23 buckets below the 50 percent limit	23
14	Crack excavation and weld repair	5 discrete cracks, Items 7, 28, 29, 33 and 78	5
15	Airfoil wall thickness dispositions, blend or weld repair	10 buckets	10
16	FPI after weld and profile restoration, control point 3	92 buckets	92
17	Post weld solution heat treatment	92 furnace exposures, cycle 2 of 3	92
18	FPI after post weld solution heat treatment, control point 4	92 buckets	92
19	Machine and EDM to restore the seal fin and cutter tooth configuration	92 buckets	92
20	EDM to recreate the Z notch and shroud profiles	92 buckets	92
21	Machine to recreate the angel wing dimensions	92 buckets	92
22	Blend of all restored features to profile	5 feature groups on every bucket, 460 blends	460
23	Dimensional and CMM verification after restoration	92 dimensional inspections and 92 CMM verifications	184
24	Final age heat treatment	92 furnace exposures, cycle 3 of 3	92

ANNEX A - QUANTIFIED HEAVY REPAIR WORK SCOPE

Step	Process, applies to all 92 buckets	Work quantity across the set	Ops.
25	FPI after final age heat treatment, control point 5	92 buckets	92
26	Masking and surface preparation for coating	92 buckets	92
27	Diffused MCrAlY reapplication by HVOF	92 applications	92
28	Post coat heat treatment to diffuse the coating into the base metal	92 buckets	92
29	Pulse thermography verification of coating bond quality	92 buckets	92
30	Coating thickness and visual acceptance	92 buckets	92
31	Moment weighing of all buckets	92 buckets	92
32	Balance chart for the complete stage	1 balance chart	1
33	Blade location labeling and wheel position assignment	92 buckets	92
34	Final visual inspection	92 buckets	92
35	Final report, serial control record and controlled packing	92 buckets, 1 set documentation package	93

ANNEX A - QUANTIFIED HEAVY REPAIR WORK SCOPE

A6. INSPECTION AND HOLD POINT SCHEDULE

Each event below is a hold point. The set does not advance to the next stage until the event is passed and recorded, and a failure at any gate returns the affected part to the repair loop.

Gate	Inspection event	Route step	Events
1	Incoming visual inspection	1a	92
2	Incoming dimensional and CMM verification	2	184
3	Wall thickness measurement	3	92
4	Z notch shroud engagement measurement	4	92
5	Incoming fluorescent penetrant inspection, control point 1	6	92
6	FPI after defect preparation, control point 2	9	92
7	FPI after weld and profile restoration, control point 3	16	92
8	FPI after post weld solution heat treatment, control point 4	18	92
9	Dimensional and CMM verification after restoration	23	184
10	FPI after final age heat treatment, control point 5	25	92
11	Pulse thermography verification of coating bond quality	29	92
12	Coating thickness and visual acceptance	30	92
13	Final visual inspection	34	92
TOTAL INSPECTION AND VERIFICATION EVENTS			1,380

ANNEX A - QUANTIFIED HEAVY REPAIR WORK SCOPE

A7. HARDWARE AND RESTORATION CENSUS

Disposition	Quantity	Detail
Restored by weld build up and re machining	460 feature groups	Seal fin, cutter teeth, Z notch, shroud and angel wing on every bucket
Engagement reconstructions	23 buckets	Z notch shroud engagement below the 50 percent limit, minimum minus 20.82 percent
Crack repairs and wall dispositions	15 locations	5 discrete cracks and 10 airfoil wall thickness dispositions
TOTAL RESTORATION LOCATIONS ACROSS THE SET	498	

A8. WORK VOLUME OF THE REQUIRED REPAIR SCOPE

Work category	Controlled operations
Cleaning, coating removal and material preparation	644
Structural weld repair, weld build up and profile restoration	314
Geometry restoration, machining and mechanical correction	736
Heat treatment, furnace cycles	368
Inspection, verification and hold point control	1,380
Coating application and acceptance	184
Receipt, assembly, documentation and release control	278
TOTAL CONTROLLED OPERATIONS	3,904

The Heavy Repair scope required by this set consists of 3,904 controlled operations across 92 buckets. It includes 314 weld build up and weld repair locations, 276 machining and EDM geometry restorations, 368 furnace exposures across four thermal cycles, 829 mandatory inspection events including instrumented pulse thermography on every airfoil, and set level moment weighing and balance charting of the complete rotating stage.

ANNEX A - QUANTIFIED HEAVY REPAIR WORK SCOPE

A9. HEAVY REPAIR - WORK PERFORMED, AND COMPARISON WITH A MEDIUM REPAIR

This set received a **HEAVY REPAIR**. We performed 3,904 controlled operations on 92 MS6001FA 2nd stage buckets. Every line below is work we carried out and recorded.

The **HEAVY REPAIR** work we performed

What we did	Controlled operations	Recorded detail
We stripped the coating and prepared every airfoil	644	All 92 2nd stage buckets, back to bare substrate
We rebuilt the seal fin, cutter teeth, Z notch, shroud and angel wing by weld	314	460 feature groups restored on every 2nd stage bucket
We recovered the geometry by machining and EDM	736	276 restorations, 23 Z notch engagement reconstructions
We ran four thermal cycles	368	368 furnace exposures across the set
We inspected and held the set at 13 gates	1,380	5 FPI control points, 368 CMM measurements
We rebuilt the coating and proved the bond	184	Pulse thermography on all 92 airfoils
We received, weighed, documented and released	278	93 2nd stage buckets weighed and balance charted
TOTAL CONTROLLED OPERATIONS	3,904	On 92 MS6001FA 2nd stage buckets

The measurements that required this work: Z notch shroud engagement below the 50 percent limit on 23 of the 92 2nd stage buckets, the worst at minus 20.82 percent, 460 feature groups out of limit, 5 discrete cracks, 10 wall thickness dispositions, and 498 restoration locations across the set.

Repair work hours for the complete set - the same hours shown on the UNEW invoice

Major task	Standard / Medium repair (hours)	HEAVY REPAIR (hours)	Difference
1. Cleaning, coating removal and surface preparation	129	322	2.5 times (+150%)
2. Welding and material build up	184	1,330	7.2 times (+623%)
3. Geometry restoration by machining and EDM	129	929	7.2 times (+620%)
4. Heat treatment	0	240	Not performed at Medium
5. Coating removal and rebuild	156	460	2.9 times (+195%)
6. Moment weighing, balancing and set control	92	316	3.4 times (+243%)
TOTAL FOR THE SET, 92 PIECES	690	3,597	5.2 times (+421%)

A Standard or Medium repair on this set of 92 MS6001FA 2nd stage buckets is 690 working hours. The **HEAVY REPAIR** we performed is 3,597 working hours. That is 5.2 times more work, 421 percent more. These are the same hours shown on invoice WO-1004061634 / WO-1004061642, where the heavy repair hours on this set are not charged to NSRP.

Reviewed and approved
UNEW Engineering



Paul McGuire
Engineering Manager