

GE Transportation Systems
Repair Specification

3/06/2013

Guidelines for Cast Iron Repair by Metal Locking
7FDL MAIN FRAME

Rev. A

REVISION HISTORY

Revision	Date	CO*	Author	Description of Revision
0	4/28/03		C. Atz	Created to track deflation of Metal Lock Repairs
A	3/06/13	150201	A. Daniels/N. Smith	Additional Metal Lock Repairs added

APPROVAL

Department	Function	Name	Date	CTQ Review
Design Engineering	Manager	Dave Furedy	3/06/2013	<input checked="" type="checkbox"/>
Engineering PE	PE	Ron Billig	2/19/2013	
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Engineering Repair Technology	Manager	Toby Norman	2/20/2013	
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Sourcing	Leader	Luciano Junqueira	3/06/2013	

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1 SCOPE

This specification defines requirements for cast iron repair by the process known as metal locking or metal stitching that is being first applied on the 7FDL diesel engine mainframe

The repair classification of this product is not relevant. This document specifies the actual repair that may be performed either in situation, at the assembly facility or at a vendor location. The Dasher RU for the mainframe assembly is 7105

1.1 Symbols

GETS	General Electric Transportation Systems, Erie, PA
RMSH	Reliability, Maintainability, Safety, and Human Factors
CTQ	Critical-to-Quality Characteristic (see section 13.2)
DRS	GETS drawing retrieval system

1.2 Definitions

Locomotive Year	8328 hours
MW-Hrs	Mega Watt Hours
CTQ	Critical to Quality
Overhaul	Removal of the Engine from the locomotive for Remanufacture
ACO Cost	Total part/service cost including material, labor and overhead
UX	Unit Exchange
Dasher	Component failure and removal tracking system
RU	Replaceable Unit
MF/LY	Mission Failures per Locomotive Year
RM/LY	Component Removals per Locomotive Year

1.3 Change Instructions and Authorization

Only technical requirements are contained in this specification.

Once this specification is released as revision 0, changes shall be controlled by a CO (Change Order - GETS internal change document). Revision letters (A, B, C, etc.) and a date shall be used to identify the latest revision of this specification.

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2 PART NUMBER AND ITEM DESCRIPTION

The part numbers in this document refer to a single type of repair, regardless of the extent of the defect. The diesel engine organization (GETS Diesel Engine COE) must be contacted if the damage exceeds the scope of repairs as defined in this document. Contact parties include diesel engine product engineering personnel and UX Inspection personnel.

2.1 Part Number & Description

This specification number plus the given part or group number shall be the GETS part or group number for this product.

Quantities for ordering or invoicing purposes are defined by the number of individual repairs performed on the casting. One casting may require multiple repairs of the same type. The repair should be invoiced by quantity of repairs noted by location or position in the casting. The casting identification such as engine SN, locomotive Road Number, or mainframe casting number should also be noted on the invoice.

<u>Rev.</u>	<u>P.N.</u>	<u>Description</u>	<u>Comments (further defined in section 4)</u>
0	84A214462P1	Crankcase Window Repair	7FDL Mainframe repair of damage to the area adjacent to the crankcase door
0	84A214462P2	Pan Rail Repair	7FDL Mainframe repair of damage to the webbed area below the crankcase door along the oil pan attachment face
0	84A214462P3	Interior Wall Repair	Repair of damage to the bulkhead walls between crank throws
0	84A214462P4	Mounting Foot Repair	Repair of the engine mounting feet
0	84A214462P5	Lube-Oil Header Repair	Repair of the area below the lube-oil header and between two cylinder bores.
0	84A214462P6	Cross-head Guide Repair	Repair of the cross-head guide area above the crankcase door.
0	84A214462P7	Special Repair	This group number is to be referenced for other repairs provided with permission from the Diesel Engine COE.

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A	84A214462P8	Extended Cross-head Guide Repair	Repair of the cross-head guide area above the crankcase door (on top of the Oil delivery groove).
A	84A214462P9	Top Deck Cross-head Guide Repair	Repair of the cross-head guide area below the top deck surface.
A	84A214462P10	Side Wall Repair	Repair of the Side Wall below the Machined crankcase window ledge.
A	84A214462P11	Power Assembly Seal Bore Repair	Repair of the top deck power Assembly (cylinder seal bore).
A	84A214462P13	Extended Crankcase Window Repair	Repair of crankcase window/cross-head guide top deck assembly.

2.2 Summary of Requirements

Product type	Cast iron structural repair without the use of welding
Outline Drawings	Main Frame Repair - 41E902116 Main Frame Inspection Criteria – 41D714799 Frame Machining – 41E914385
Supplier & Cat. No	Approved source is MLS (Metal Locking Service), Buffalo, NY
Construction type	Steel locking plates and Steel threaded stitch pins.
Cooling required	Not Applicable
Temperature range	-40 F to 300 F
Rating / Capacity	Meets requirements of un-repaired casting. May be applied to all 7FDL mainframes regardless of rated horsepower of original frame.
Other Features	Repair should not be easily detectable by naked eye without close inspection. Inserted material should blend to original material without steps or sharp edges.

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3 APPLICABLE DOCUMENTS

The following documents form a part of this specification to the extent specified herein. The revision in effect when the Purchase Order is issued to the Supplier shall apply. Documents are listed in the order of precedence. Referenced documents are available from GETS or are available as an industry standard.

<u>Title of referenced document</u>	<u>Document Number</u>	<u>Location</u>
Purchase Order		Sourcing
Guidelines for Cast Iron Repair by Metal Locking	84A214462	DRS
Mainframe Allowable Metal Lock Repair Combinations	84A214462RC	DRS
GETS Environmental Requirements Spec	84A200750CB	DRS
GETS Quality Standards Specification	41A296300AC	DRS
GETS Reliability Standards Specification	41A296300AD	DRS
Mainframe Drawings	41E914385	http://ssogets.trans.ge.com/drawingret/cgi-bin/main.pl?fdrgno=41E914385&eworkstation=
Mainframe Drawings	41R992525	http://ssogets.trans.ge.com/drawingret/cgi-bin/main.pl?fdrgno=41R992525&eworkstation=
Mainframe Drawings	41R992258	http://ssogets.trans.ge.com/drawingret/cgi-bin/main.pl?fdrgno=41R992258&eworkstation=
Mainframe Cast Iron Material Spec	C50E69A	DRS
Mainframe Assembly Drawings	84D721160	DRS
Mainframe Inspection Criteria	41D714799	DRS
Mainframe Repair Drawing	41E902116	DRS

Locations: Sourcing GETS Sourcing organization
 DRS GETS Drawing Retrieval System
 Industry Available as an Industry Standard

4 BILL OF MATERIAL

No Items are replaced as part of the repairs stated in this specification; cast sections used for metal lock repairs are taken from scrap or donor frames.

5 SPECIAL TOOLS LIST

No special tooling required.

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6 REMANUFACTURING REQUIREMENTS

The repair shall comply with all stated requirements as defined below.

6.1 Scope of Repair

There are currently eleven different types of repair that are commonly applied to the 7FDL mainframe. A description of each repair and the regional limits of the repair are described below. Damage that extends beyond the limits described should be reviewed and approved by the repair vendor and GETS personnel on a case-by case basis.

The repairs may be classified as damage repair, defect repair, or crack repair. In the case of damage or defect repair, the affected region is removed from the casting and a replacement casting is locked in place. The replacement material must meet or exceed the requirements of C50E69A or be taken from a donor (scrap) casting. A crack repair does not involve significant material replacement. Each repair may include some combination of material replacement and crack repair.

The damage repairs are typically associated with a major engine failure such as a connecting rod failure. Crack repairs may be associated with locomotive wreck repair. The repairs may also be applied to casting defects on used frames and on new frames with GETS engineering approval.

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6.1.1 Crankcase Window Repair - 84A214462P1

Repair of damage to the area adjacent to the crankcase access door.

Laterally, the damaged region must be confined to the exterior wall of the mainframe as shown in figure 1. In the vertical direction, the repair should not affect the crosshead guide bores above the window; and should not extend into the pan rail flange below the window.

Grove City Engineering or UX inspection personnel should review mainframes that require crankcase window repair and pan rail repair at the same position.

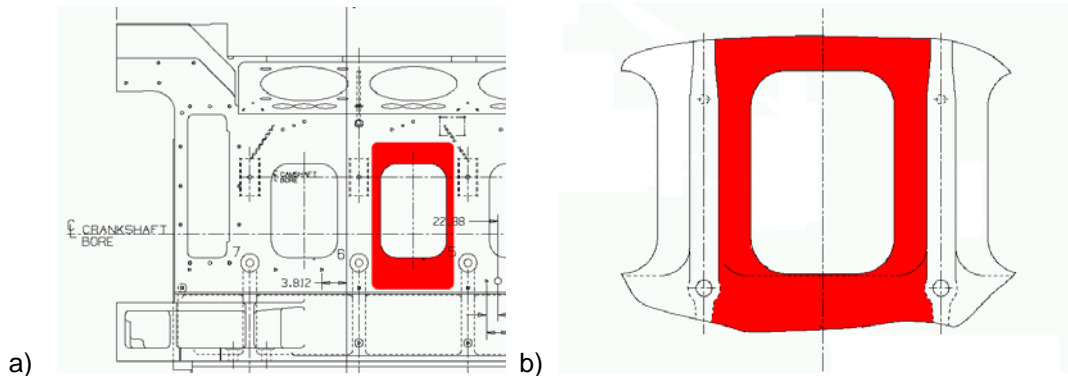


Figure 1. Repairable Areas for 84A214462P1

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6.1.2 Pan Rail Repair - 84A214462P2

Repair of damage to the webbed area below the crankcase door along the oil pan attachment face.

The repaired region must be within the two interior walls and may not extend beyond the inside face of the exterior wall as shown in figure 2. The pan rail region must be ground flush or re-machined as required to meet the dimensional requirements of a UX mainframe.

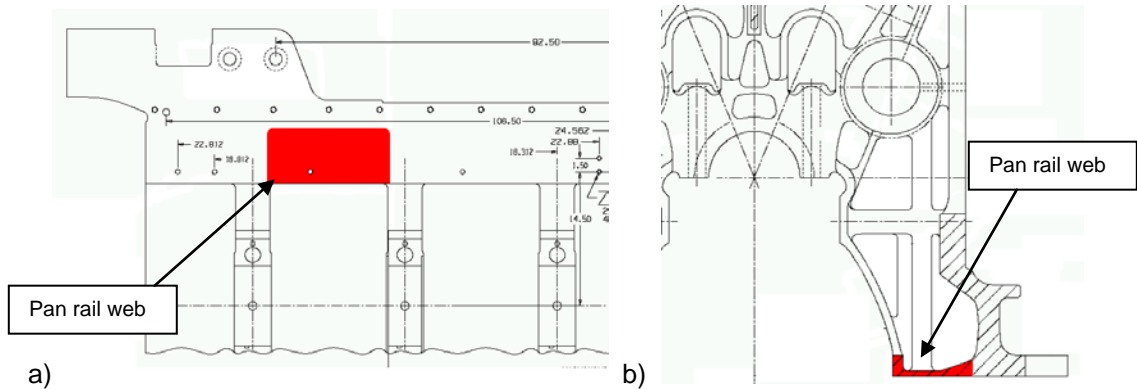


Figure 2. Repairable Areas for 84A214462P2

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6.1.3 Interior Wall Repair - 84A214462P3

Repair of damage to the bulkhead walls between crank throws.

The repaired region must not extend upward to the cam boss region or outward to the exterior wall as shown in figure 3. The repair may not include the side bolt boss or drilled region. The repair may include the "T" section of the bulkhead archway below the side bolt, however it is common to blend out the missing half of the "T" flange.

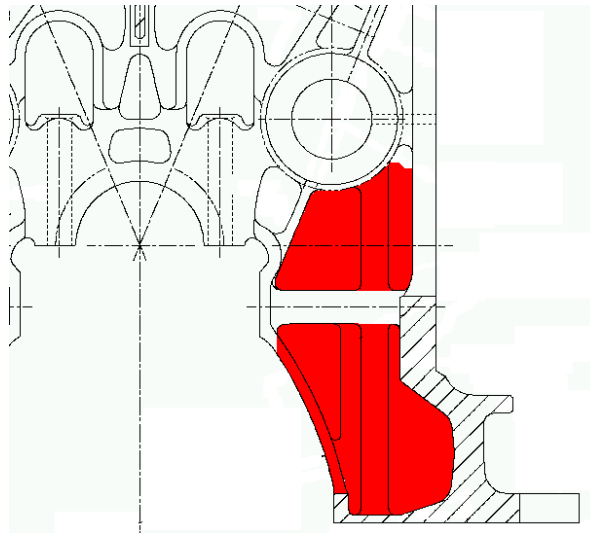


Figure 3. Repairable Areas for 84A214462P3

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6.1.4 Mounting Foot Repair - 84A214462P4

Crack repair of the engine mounting feet.

The mounting foot repair may include repairs to the front and rear engine mounting feet and cracks in the alternator mounting feet. These are typically simple crack repairs, not usually associated with replacement of damaged material. Material replacement has been associated with the “pull-out” of the forward mounting foot. The typical repair does not extend beyond the limits shown in figure 4. Any repair that exceeds these limits should be considered a G7 and should be reviewed by GETS personnel.

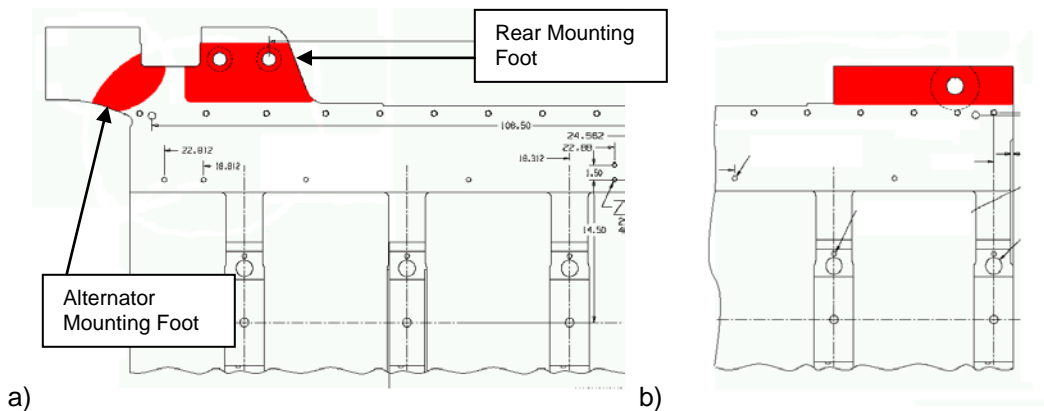


Figure 4. Repairable Areas for 84A214462P4

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6.1.5 Lube-Oil Header Repair - 84A214462P5

Repair of the area below the lube-oil header and between two cylinder bores above the centerline of the crankshaft.

This repair is most commonly associated with casting defects and would normally be applied at overhaul. The repaired region must not extend upward into the lube oil header pipe or outward to either of the adjacent interior walls as shown in figure 5.

These repairs are often associated with a crack that extends upward from the rib. These cracks may extend as far as the lower edge of the cylinder bore and may be repaired by simple crack repair and without material replacement. Any repair in excess of what is described here should be considered a G7 – Special Repair and should be reviewed by GETS personnel.

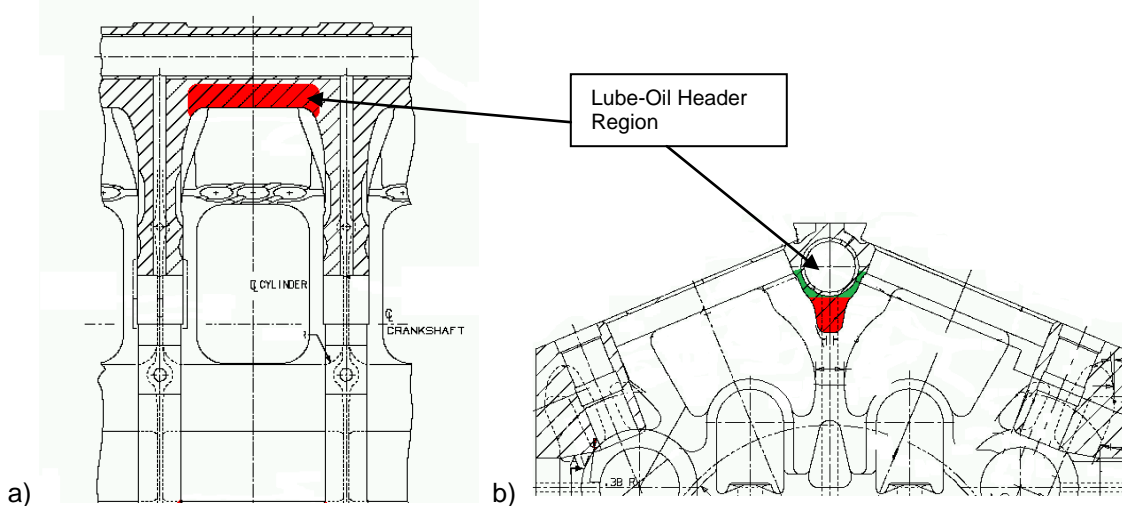


Figure 5. Repairable Areas for 84A214462P5
(Mainframe axial section showing lube-oil header and crosshead guide repair region. Material replacement is in RED and crack repair region is in PINK.)

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6.1.6 Cross-head Guide Repair - 84A214462P6

Repair of the crosshead guide area above the crankcase door.

Damage to the crosshead guide bore cannot extend closer than ¼" (6.4 mm) from the bottom of the oil delivery groove. The damage may not extend into the adjacent interior walls of the mainframe as shown in figure 6. The crosshead guide bores must be re-machined to meet all UX dimensional standards.

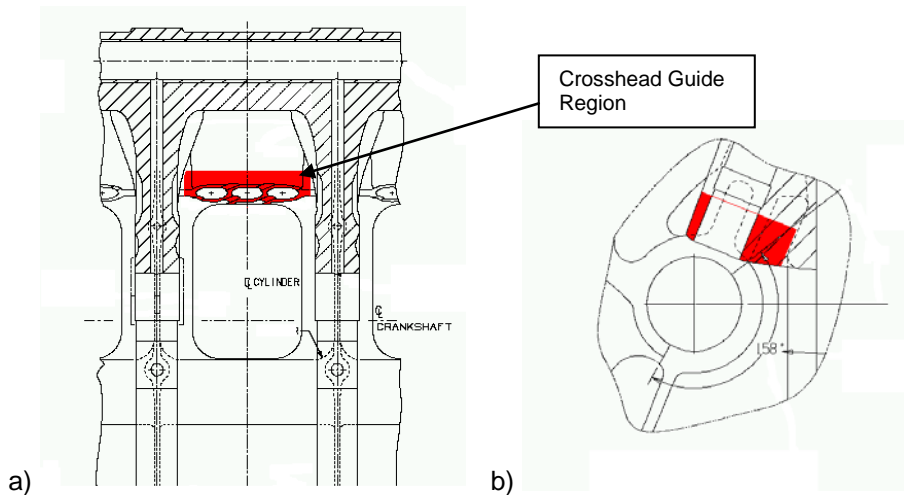


Figure 6. Repairable Areas for 84A214462P6

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6.1.7 Extended Cross-head Guide Repair - 84A214462P8

Damage to the crosshead guide bore cannot extend more than ¼" (6.4mm) above the top of the oil delivery groove. The damage may not extend into the adjacent interior walls of the mainframe as shown in figure 7. The crosshead guide bores must be re-machined to meet all the UX dimensional standards.

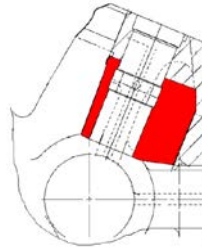


Figure 7. Repairable Areas for 84A214462P8

6.1.8 Top Deck Cross-head Guide Repair - 84A214462P9

Damage to the crosshead guide bore cannot extend closer than ¼" (6.4 mm) to the top of the oil delivery groove. The damage may not extend into the adjacent interior walls of the mainframe as shown in figure 8. The crosshead guide bores must be re-machined to meet all UX dimensional standards.

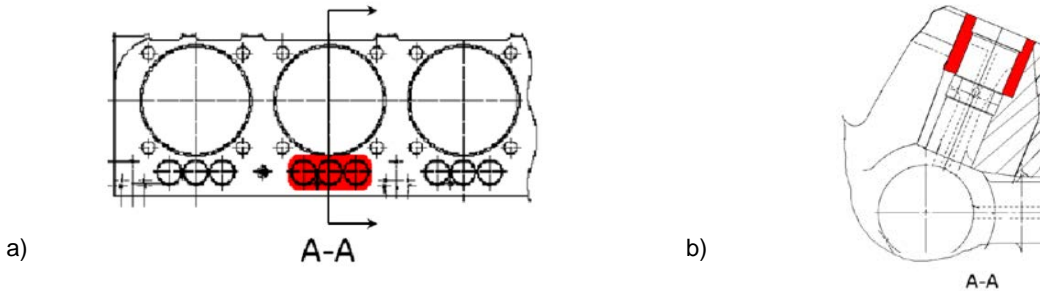


Figure 8. Repairable Areas for 84A214462P9

6.1.9 Side Wall Repair – 84A214462P10

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Damage to the side wall cannot extend closer than within 2" (50.8) of the machined pan rail surface. The damage may not extend into the adjacent interior walls of the mainframe as shown in figure 9.

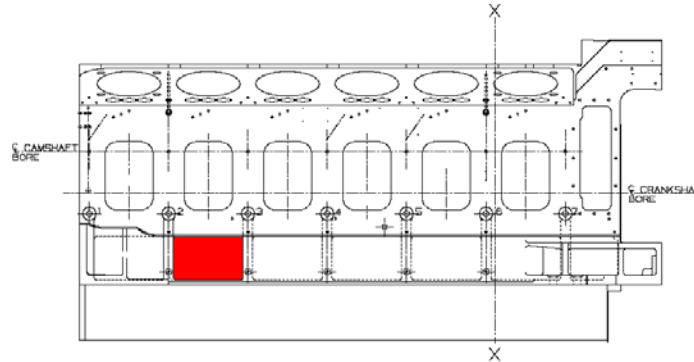


Figure 9. Repairable Areas for 84A214462P10

6.1.10 Power Assembly Seal Bore Repair - 84A214462P11

Damage to the top deck cylinder seat and power assembly seal bore cannot exceed 7.156" (181.8mm) radially from center of the bore. The allowable area to be repaired is shown in figure 10.

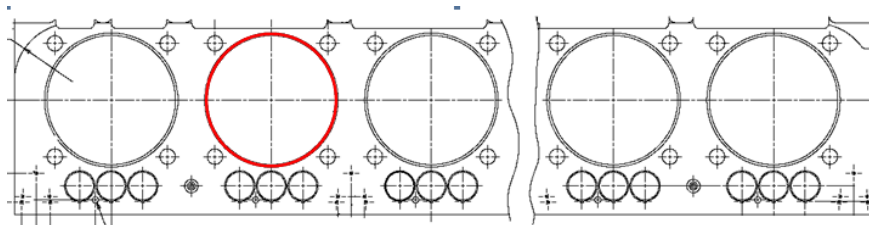


Figure 10. Repairable Areas for 84A214462P11

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6.1.11 Extended Crankcase Window Repair - 84A214462P13

Damage to this assembly area must be limited to 1 area per frame. Damage cannot extend into either of the adjacent interior walls or into either of the adjacent power assembly nut pockets as shown in figure 11.

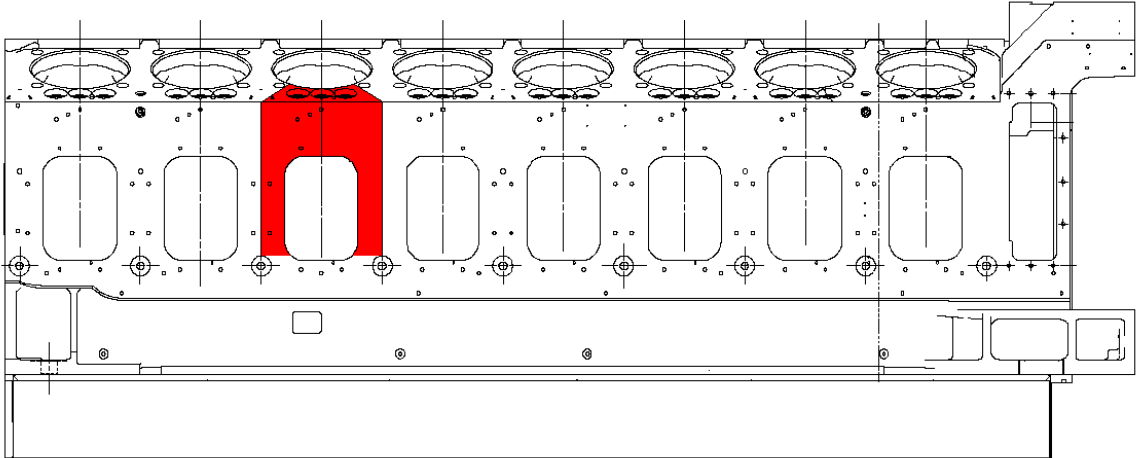


Figure 11. Repairable Areas for 84A214462P13

6.1.12 Special Repair - 84A214462P7

This group number is to be referenced for all other “special” repairs provided with permission from the Diesel Engine COE.

6.2 Structural Strength Requirements

The repaired region must maintain the same tensile strength and fatigue properties of the un-repaired material. Stress concentrations or excessive residual stresses must not be imparted on the casting as a result of the repair.

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6.3 User/Customer Requirements

Repair surface should be peened completely and should not be visually different from an un-repaired casting without close inspection.

6.4 Engine Overhaul Requirements

The repaired casting must be able to flow through the standard UX process at Grove City and at other rebuild facilities without special consideration. Standard cleaning, inspection and machining process associated with reconditioning and component rework will be applied at approximately 6-year intervals.

6.5 Mechanical Requirements

The repair shall comply with all stated requirements. The repaired casting shall perform no differently than a new or un-repaired UX casting

General – Replacement material to meet the minimum requirements specified in C50E69A.

Size, shape, weight – Size limitations specified in Section 4 of this document. The repair should attempt maintain the same shape and surface contour as the original casting. The repaired casting must pass all inspection criteria (41D714799) after all finish work and associated machining have been applied.

Envelope – The repaired frame should meet the requirements applied to a UX frame 41D714799 & 41E914385

Finishes – The repaired surface should be peened completely and should not be visually different from an un-repaired casting without close inspection

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6.6 Materials & Workmanship

The repair shall comply with all stated requirements. Repair components may be purchased or custom machined by the vendor

Fasteners – Stitch pins to be of high quality steel (35 Ksi Minimum Yield Strength).

Locks – Locks should be precision machined and of high quality steel (35 Ksi Minimum Yield Strength).

Cast Material – Replacement material to meet the minimum requirements specified in C50E69A

Tools – Drills, Grinders, Taps shall be maintained

Sharp edges and burrs – No sharp edges or burrs allowed on completed repair

Welds – No welding shall be applied to any of the repaired regions specified in this document.

6.7 Environmental Requirements

The product shall be designed to meet or exceed the environmental design requirements specified in the Environmental Requirements Specification; GETS document 84A205544.

The engine mainframe is the primary structural component of the diesel engine. The repair will be subject to the high temperature, high vibration environment typically associated with engine operation.

6.8 Reliability Requirements

This repair will not compromise the reliability of the casting. The repaired casting shall meet or exceed the reliability requirements of an un-repaired casting.

The allocated reliability of the mainframe assembly is 0.0001 MF/LY and 0.0012 RM/LY

7 FINAL INSPECTION / FUNCTIONAL TESTING

Final inspection of repaired frames will include dimensional adherence (with tolerances specified) to all affected areas per new print; including but not limited to: cross-head bores, cylinder bores, all drilled/tapped mounting holes, and crankcase windows

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8 REMANUFACTURE'S RESPONSIBILITY

The Supplier is responsible for meeting all requirements of this specification and other referenced specifications and standards. The Supplier shall submit a list of exceptions with the proposal offer. All exceptions must be approved in writing by the Purchaser prior to final acceptance and shipment of the product.

8.1 Reliability Plan

A Reliability Plan and a corresponding Implementation Schedule shall be defined by the Supplier and approved by the Purchaser. These materials shall accompany the Supplier's proposal in response to this purchase specification and related solicitation.

Current approved suppliers may waive this step if they meet the grandfathering conditions associated with QSW xxx.

8.1.1 Mission Reliability

The repaired casting shall have a 99.94% probability of successfully performing its intended mission function (as defined in 10.6) over the specified useful life under the operational and environmental conditions outlined herein. Mission failures are those primary failures, which result in the inability of component to perform its functional CTQs.

99.94% success rate is equivalent to 0.0001 MF/LY and applies to the entire mainframe assembly. The repair cannot compromise mission reliability.

8.1.2 Removals Reliability

The product shall have a 99.28% probability of successfully performing all defined functions over the specified useful life under the operational and environmental conditions outlined herein without removal.

99.28% success rate is equivalent to 0.0012 RM/LY and applies to the entire mainframe assembly. The repair cannot compromise mission reliability.

8.1.3 Mission Reliability Demonstration

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It is required that the supplier demonstrate before full production launch, a minimum mission reliability of 99% over the useful life (10.3) of the supplied component or system. It must be made with a statistical confidence of at least 95%. The qualifying tests must include at least all mission and safety critical failure modes identified by FMEA.

An example of an approved validation matrix and a detailed test plan are included in the attachments to this document (attachments I and II). New vendors must be approved through the new component introduction (NCI) process.

8.1.4 Useful Life

The useful life of the repaired mainframe shall be no less than an un-repaired mainframe. Currently 20 years under any combination of storage or service life.

8.1.5 Mission Critical Function

The mission critical functions for the repaired mainframe are defined as follows:

- Structural support of engine operating components, both internal and external
- Transmission of lubricating oil to engine bearings without loss of pressure or external leak
- Secure engine and attached components to the locomotive platform

8.2 Quality Plan

The success of this repair is based strongly on the craftsmanship of the repair technician. Any device, tool or fixture that may improve the ergonomic conditions of the repair should be applied.

Each craftsperson should be trained in the repair procedure. The vendor shall keep updated qualification and certification records of approved craft personnel.

8.2.1 Documentation Requirements

Each repair will be documented and records of the repair shall be kept at the vendor. These records are to include the engine serial number (if applicable), the frame casting number, the location of each repair by engine position, the date of repair, the physical location where the repair was performed, and the name of the craftsperson performing the repair.

Documented work instructions and standards for acceptance will be created and controlled by the vendor.

8.2.2 Communication

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The sole channel of communication between the Purchaser and the Supplier in all matters related to the establishment or alteration of contractual requirements to be fulfilled by the Supplier shall be through the GETS Sourcing Agent.

A formal documentation system shall be used to track the exchange of technical data and information between the Purchaser and the Supplier.

The exchange of technical data and information not affecting change control, cost, or delivery may be communicated directly between Supplier and Purchaser engineering organizations and followed up by memos through the Sourcing Agent of the Purchaser.

8.2.3 Design Reviews

The Supplier shall conduct design reviews for major development phases of the product, as applicable. The Purchaser and Supplier shall agree to the quantity, scope, and schedule of the planned design reviews. The Purchaser shall be notified at least one month in advance of the review and will participate in all reviews.

8.2.4 Technical Support Availability

Technical support shall be agreed upon between the Purchaser and Supplier. As part of the response to this specification, the Supplier shall provide a description of the type of technical support available to GETS.

Technical support considerations shall include on-site training, on-site product integration, maintenance manual documentation, phone support, and post delivery field services.

Maintenance manual documentation shall be provided by the Supplier, with periodic updates, covering the design and implementation of the product modifications.

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9 PACKAGING AND MARKING

9.1 Marking/Nameplates

Markings for products shall be located so that they may be seen and identified by maintenance or operational personnel from the normal access position when the product is installed.

All Nameplates are to be securely fastened in the original location intended by GET. The following information is to be appropriately stamped and clearly legible:

- Model number
- Serial number (original)
- Completion date of service, year – month (example 03 – F)
- Re-MFG Name or Symbol

9.2 Packaging

Products shall be packaged for shipment to GET in such a manner that leads, terminals, cases, etc. are protected from mechanical damage such as breaking and bending or electro-magnetic damage. Mechanical damage of any nature shall be sufficient cause for rejection. The shipping carton shall be marked with the GET part number, the supplier part number, the quantity of items included, and other pertinent information. All wooden skids and boxes are to be securely assembled exhibiting NO SHARP OBJECTS (NAILS, SCREWS, STAPLES) ON WHICH INJURY CAN OCCUR.

10 RELIABILITY/WARRANTY/LICENSING

Reliability requirements are as defined in sections 8.1.1 & 8.1.2 of this document. The warranty shall be defined in the purchase contract and administered by GETS Sourcing.

This document was reviewed:

- for CTQ characteristics by: _____(name) _____(date)
- for Reliability requirements by: _____(name) _____(date)
- for Specification Release by: _____(sponsoring mgr.) _____(date)

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APPENDIX A: TEST PLAN FOR CAST IRON REPAIR FATIGUE TEST

OBJECTIVE:

The purpose of this test is to demonstrate the relative fatigue strength of material repaired by the metal locking or metal stitching process. The repaired and as-cast material will be evaluated in the form of a test bar that is loaded in the axial direction. The loading will be applied cyclically and the load will increase in a step fashion.

BACKGROUND:

Cast iron repairs have been applied to the 7FDL main frame for many years. These repairs have demonstrated good reliability (zero known failures) in the areas that they have been applied.

The proposed test will be used as part of the approval requirements for Purchase Specification 84A214462.

TEST PLAN:

Test Pieces (to be supplied by GETS engineering):

See proposed test bar drawings shown in Figure 1.

Qty 6 84A213xxxP1 - Test bar – Not Repaired
Qty 7 84A213xxxP2 - Test bar – Repaired

Parts will be identified with 2 digit designation as follows:

B1 to B6 – Un-repaired sample
R0 to R6 – Sample repaired bars (R0 is for trial run)

Test Equipment:

- A) Dynamic loading axial test machine and monitor/control/reporting equipment capable of sinusoidal or pulse loading to 80,000 lbs.
- B) Fixtures for holding the test bars in both tests. (the bars will be designed to minimize the amount of fixture creation)

Relevant Documents:

84A214462 GETS Specification: Cast Iron Repair by Metal Locking
41A222348 GETS Drawing: Engine Rebuild Instructions
41E902116 GETS Drawing: Main Frame Repair

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C50E69A GETS Specification: Special Alloy Gray Iron, Main Frame Castings
(37.5 ksi UTS in heavy wall sections)

Test Conditions:

The applied loads should be axial with static or dynamic bending loads minimized. A strain gage may be applied to the part to monitor the part stress (to be discussed with the test lab).

Test Details:

1. Perform dynamic fatigue test per Table 1 on sample R0 (this is the trail part, see Figure 1 and 2 for details).
2. Adjust the start point of the testing based on the failure point of R0 after review with GETS engineering.
3. Perform step fatigue test per Table 1. Test 12 samples in randomized order (three samples of each type)
4. Record the total number of cycles to failure, the load or load step at failure and the number of cycles at the failure load.
5. Return failed samples and data to GETS Engineering contacts:

1503 West Main Street, Ext.
Grove City, PA 16127
(724) 450-8107
(724) 450-8174

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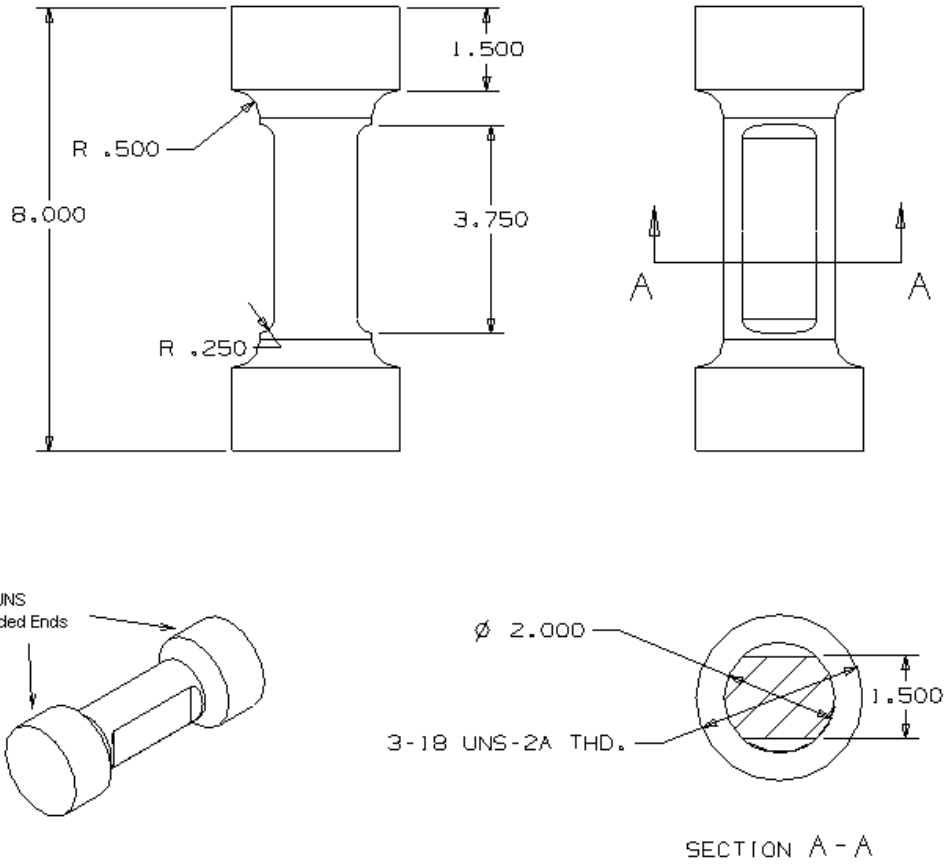


Figure 1: Test bar geometry. Bar is to be cut into 2 symmetric pieces and repaired.

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TABLE 1: Planned Load Steps for Cast Iron Bar Fatigue Test

Test Cross Sectional Area =	3.75	in ²
Cast Iron UTS =	37500	psi
Cast Iron Endurance Limit =	16875	psi
Start Stress =	12656	psi
Stress Step =	1266	psi

Load Step	# cycles at step	Stress Amplitude (peak)	Force Amplitude (peak)
1	1.00E+06	12656	47461
2	1.00E+06	13922	52207
3	1.00E+06	15188	56953
4	1.00E+06	16453	61699
5	1.00E+06	17719	66445
6	1.00E+06	18984	71191

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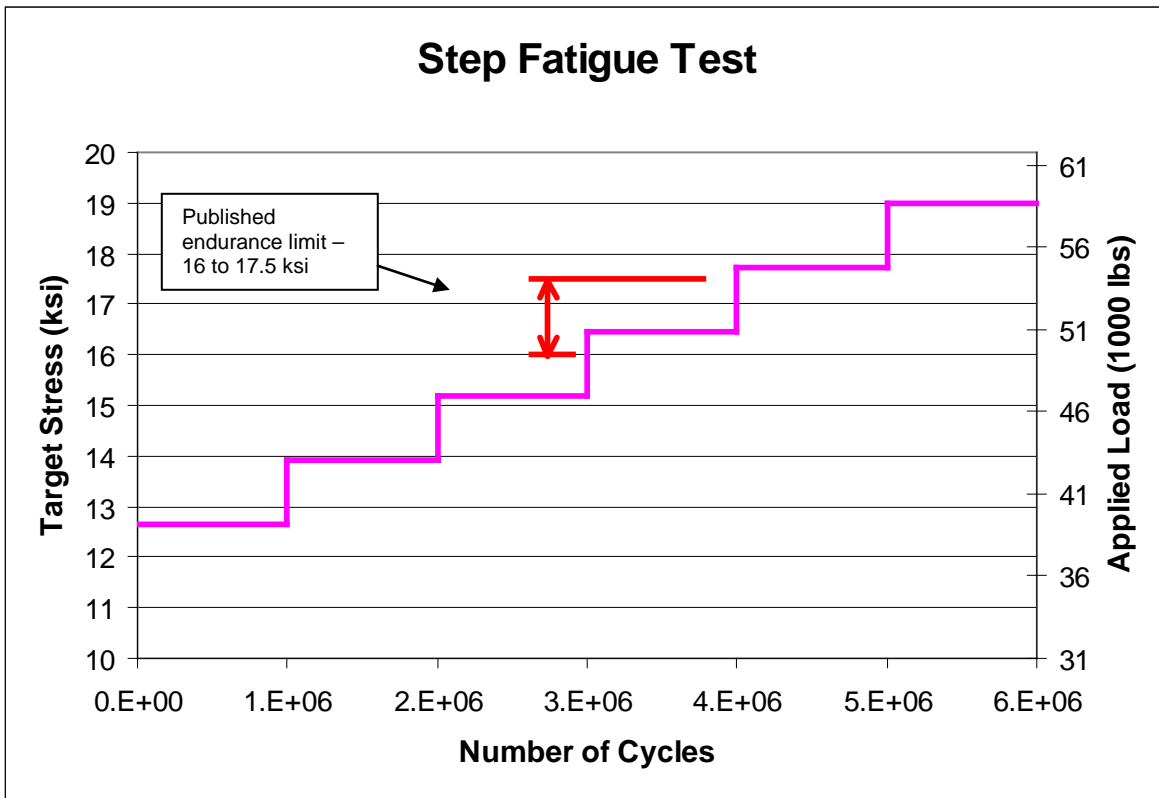


Figure 1: Example of step fatigue test showing published endurance limit range for material

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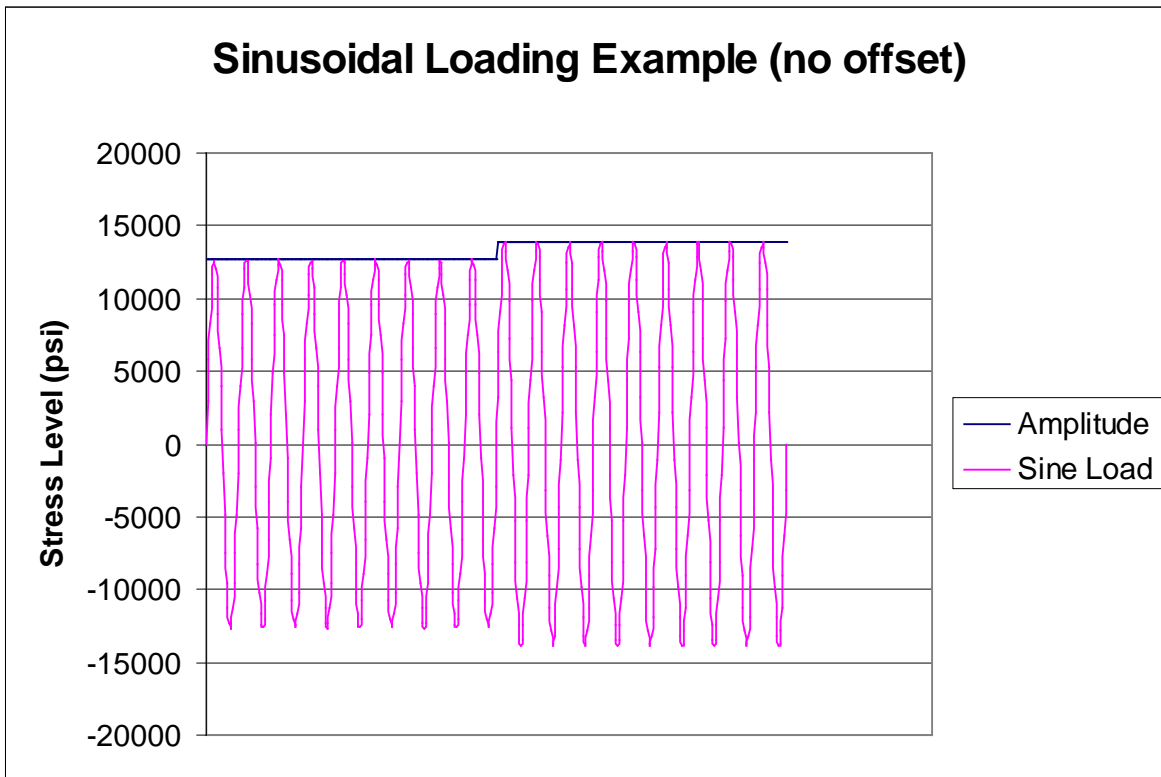


Figure 2: Example of loading with zero offset

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APPENDIX B: EXAMPLE VALIDATION MATRIX FOR NEW REPAIR VENDORS

Component: 7FDL Mainframe Repair _____ Dwg. Nos.: Repair Spec. 84A214462 _____

Change Description: New Vendor _____ NCI #: TBD _____ Design Folder: TBD _____

Ref. Component Design Spec. No. None		Verification				Validation		
Requirements	Criteria	Design Control	Resp.	Plan	Results	Resp.	Plan	Results
Material	Meet design intent	Drawings Material Spec	DE, Vendor	Review repair material and BOM with vendor		DE	Simple material checks of repair hardware (Hardness test) Visual review of general quality	
Form	No errors on drawings and specs. Parts made to print.	Drawings Material Specs	DE, Vendor	Drawing / Spec review		DE	Visual inspection of repaired area	
Fit	Assembles into next assembly.	Assembly drawing	DE, Vendor	Establish fit requirements and checking process for replacement material		DE, QE	Visual Inspection of repaired area	
Function	Meets design intent.	Drawings Material Specs	DE	Visual inspection of vendor demonstration trials Evaluation of ultrasonic testing for process control		DE, QE	Visual Inspection of repaired area Die penetrant inspection of repair Acceptance test at GC test cell (no leaks)	
Performance / Emissions	Meets required emissions and performance	ECC list SDS SFS		None			None – This is not an ECC. This change will not affect engine	

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	targets.						performance or emissions.	
Reliability	R \geq 0.99 @ T=12 mos (with 95% confidence) before >50% cut-in	Drawings Material Specs	DE, Test lab.	1) Fatigue test of repaired bars 2) Calculate reliability of other metal lock repairs from current vendor		DE, QE	<i>Expect failure away from repair... use reliability of un-repaired frame for cut-in</i> Repair 10 engines. Reviewed by UX frame inspection (GC) for repair quality and repeatability	
Durability / Life	\geq 6 years or \geq 26,000 MWH to overhaul (16cyl) \geq 2 overhauls	Drawings Material Specs		Same as above			Same as above	
Maintainability	TTR \leq current and operator access OK	Drawings Material Specs		None			None	
Manufacturability	Dimension 4 sig or better	Drawings Material Specs		None			None	
Weight	No significant weight change	Drawings Material Specs		None			None	
Cost	\$ ACO < 0.9 x current	Quotes / P.O.s	CA	Compare quote to current		CA	Compare P.O. to current after 12 mos	

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Revision Date: 3/7/02

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