GTEN 2023 Symposium

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# Aeroderivative GT Overhaul 101


Presented by:

Steve Willard P.Eng



**Presented at the Gas Turbines Energy Network (GTEN) 2023 Symposium**
**Banff, Alberta, Canada - October 2023**

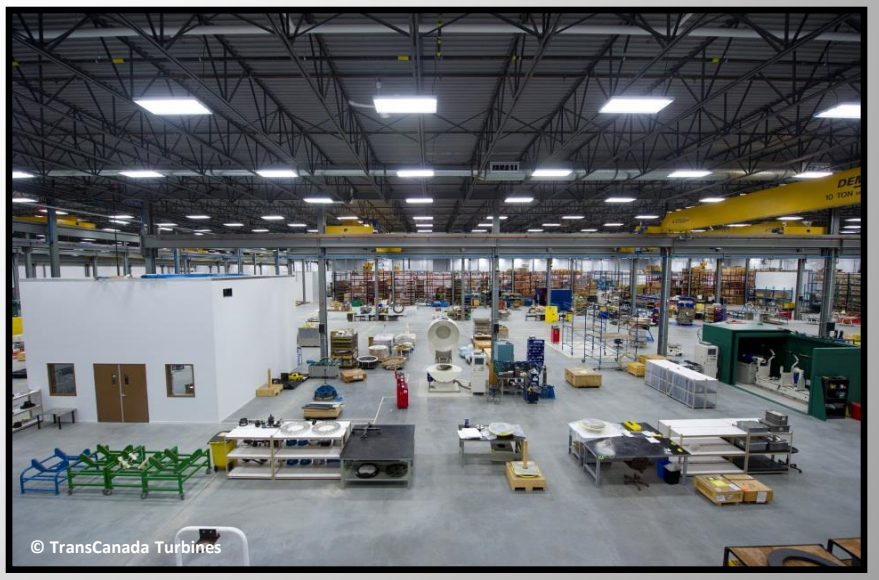
# Who is TransCanada Turbines (TCT)?

- TCT is an Authorized Service Provider (ASP) licensed by **both** General Electric (GE) and Siemens to maintain, repair and overhaul certain aero-derivative Gas Turbine (GT) engines.
- Derived from jet engines on an aircraft, these GT's drive equipment such as generators for power generation or gas compressors to push gas down pipelines.
- With a Best-in-Class GT overhaul facility and field service branches staged throughout the world, TCT is capable of servicing and maintaining engines globally.
- TCT has been in the industry for over 25 years
- TCT's parent company owns and operates >400 GT's which has provided TCT valuable knowledge from an operators perspective:

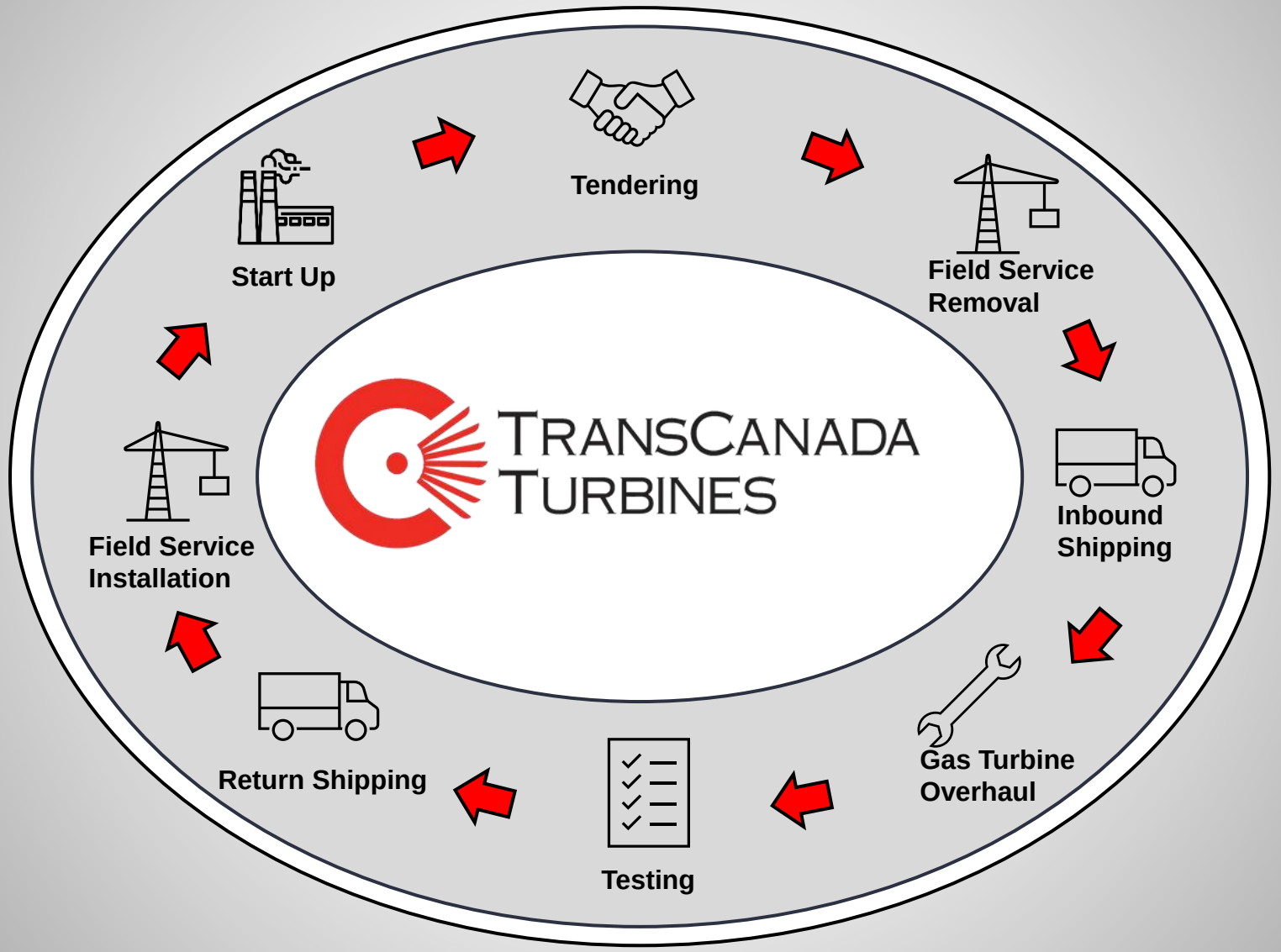
  "The need for quick response and fast solutions to bring engines back to serviceable condition as soon as possible"

# Who is TransCanada Turbines (TCT)?

- **TCT in 1998**
  - 1 overhaul depot, 1 test cell
  - Limited OEM licensing
  - First overhaul completed by early 1999.
  - TCT has steadily increased international presence and strengthened service offerings
- **TCT in 2023**
  - 2 comprehensive OEM Licenses: Siemens & GE
  - 4 Level II field service centers
  - 1 220,000 sq. ft. Level 4 overhaul depot
  - 2 engine testing cells

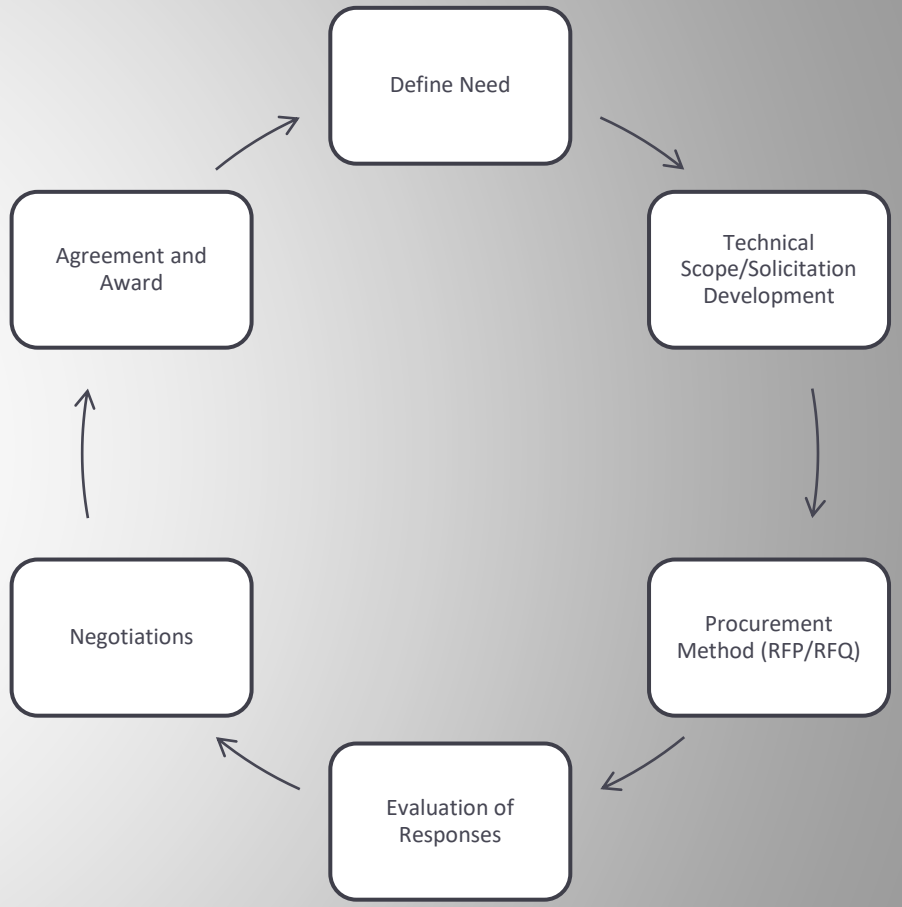
# Process Overview



# Tendering Process

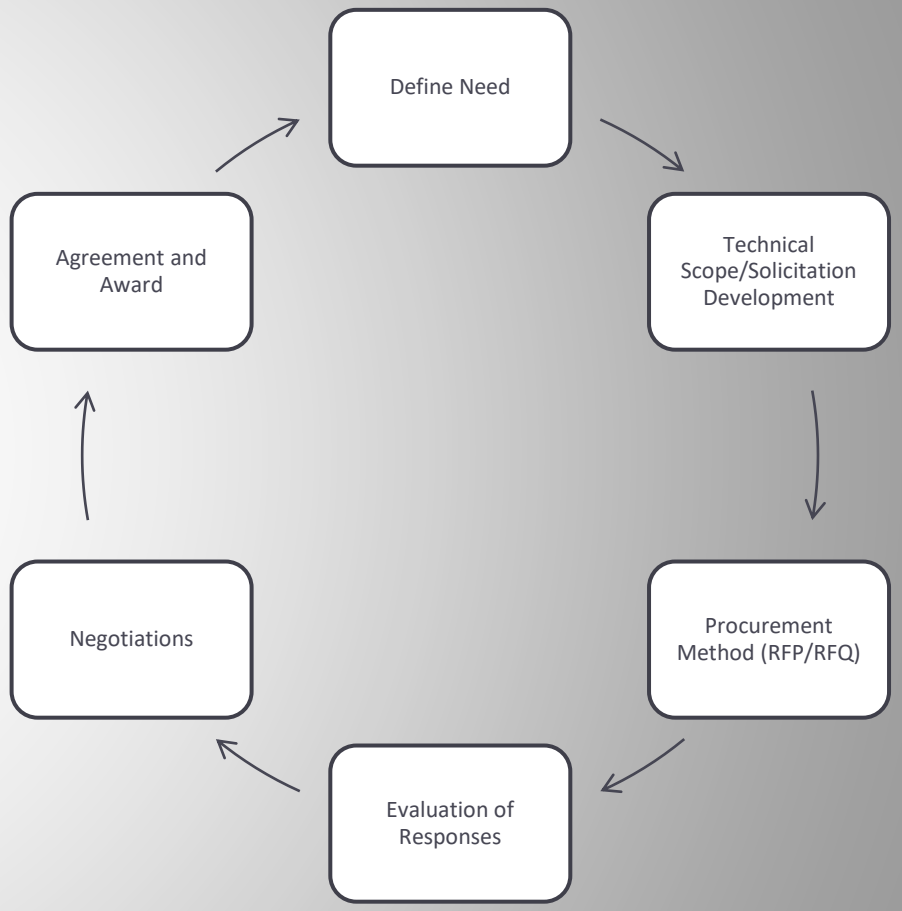
- **Need**
  - Repair vs Overhaul vs Exchange
  - Key Considerations
    - Timing & Budget (allow for contingency)
    - Reliability vs Risk Tolerance

- **Technical Scope**
  - Technical Bulletin or Upgrade needs
  - Engine Performance Expectations
    - Power, Heat Rate, Vibration
  - New vs Overhaul part replacement
  - Lessons Learned
  - Apple to Apple Insurance
  - Vagueness -> Cost Increases



# Tendering Process

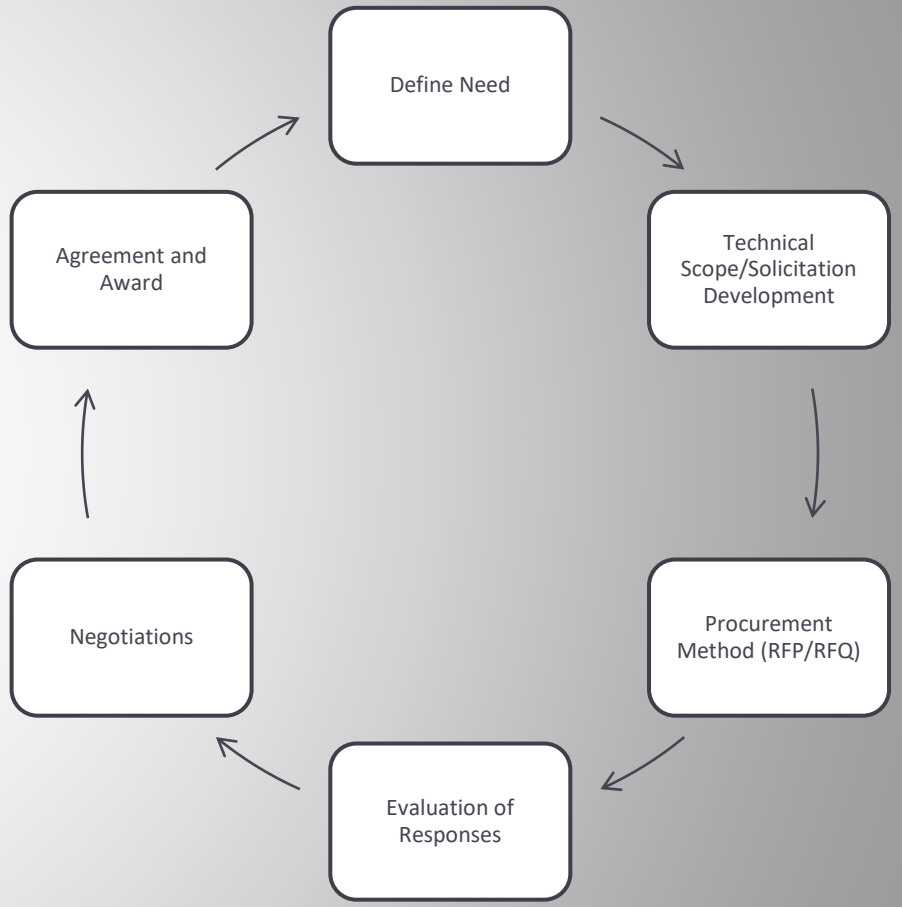
- **Procurement Method**
  - RFP's can be more time consuming but usually more detailed and include Term and Condition Expectations.
  - RFQ's can be quicker but can be less detailed and usually rely on existing terms and conditions
  - Allow time for clarifications
- **Evaluation**
  - Review competing bids to ensure alignment with needs
  - Grade against pre-determined Needs vs Wants vs Nice to Have's
  - Past Performance Considerations



# Tendering Process

- **Negotiations**
  - May need to refine scope expectations
  - Term and Conditions if not pre-existing
    - Can be very time consuming so allow adequate time
  - Price vs Time vs Scope

- **Award**
  - Need to Award can typically take weeks or months pending on internal and external policies and expectations.
  - Confirm start dates and resources
  - Recognize this is just the beginning….



# Field Service

- **Topics Covered:**
  - Key site considerations
    - Pre outage site survey
    - Safety Considerations - Crane and lifting devices
  - GT Removal & Prep for Transportation
  - GT Installation and Recommissioning
  - Outage Timelines – Manpower & Shifts

# Field Service

- **Key Site Considerations**
  - **Site survey in preparation for engine removal or exchange**

1. Aids in accounting for hardware that may be required to remove the gas turbine from the GT package including:
   - ✓ H-Frame assembly, unique hardware, concrete anchor stud for H-Frame columns.
   - ✓ Engine lift fixture, cabling, shackles, pins
   - ✓ Gas manifold support equipment
2. Evaluation of site layout for placement of shipping container, maintenance dolly, GT support pedestals, tractor-trailer, and mobile crane. Surface type/foundations for H-Frame and Mobile Crane site.
3. Understand availability of plant manpower to support, forklift and manlift availability

# Field Service

- **Planned Crane and Chain Hoist Lifts**

**GE Service Letter SL-6000-09-01 Excerpt**

> **In the absence of local regulations, it is required that a crane be tested at 110% load, but no greater than 125% of its rated capacity at least every 12 months.**
>
> GE Field Services personnel are being asked to verify this requirement has been met prior to use of the lifting device and will not use the lifting device (and thus perform affected work) until validation is provided or load test is completed. In general, documentation showing dated certification of the device or demonstration and witness of load test by a qualified party will suffice.


Load Test of GT Lifter


Assembled GT H-Frame Prior to Load Test


Load Test in Progress of 8.6-ton Chain Hoist and H-Frame

# Field Service

- ## Field Preparation for Shipment


GT will be removed from pckg. and placed on pedestals, in a rolling maintenance dolly or directly into a shipping container. This is depending on space available next to GT package (as evaluated during pre-outage Site Survey)


GT secured & sealed in container and transferred to Air Ride truck and trailer. Visual confirmation **BOTH truck & trailer** are equipped with air ride suspension. See proper securing guidance in Logistics slides.

- Detailed procedures for GT Removal and Prep to Ship are typically provided in the site OEM documentation. Outage time can be optimized if all involved plant personnel have access to these documents and have reviewed these procedures prior to the outage.
- **Example for LM6000 PD:**

These work packages/WP can all be found in your GEK 105061 O&M Manual
**WP3010**: GT Replacement
**WP3012**: Use of rolling maint dolly
**WP3013**: Use of GT Pedestals
**WP3014**: GT placement into Shipping container

# Field Service

- ## Gas Turbine Installation and Recommissioning

  - GT Installation and Recommissioning procedures can typically found in the site OEM documentation and should be closely adhered to by both your selected GT Field Service Provider and Plant Personnel.  May contain relevant information like:
    - ✓ Work Site Hazard Assessment / Job Specific Safety Analysis
    - ✓ Pre-Start Check list
    - ✓ LOTO sign-off
    - ✓ Dry Motor Inspection
    - ✓ Start Sequence and Sync Idle Inspections
    - ✓ Evaluation of Operation Data and completion of Run Data Log
    - ✓ Dry Low Emissions Mapping (if applicable)

  - Recommend engaging an OEM Authorized Service Provider that can assist with pre-Outage Site Survey; able to provide Field Personnel Training Certifications, and able to work closely with Plant Personnel to plan a Safe and well-organized outage.

# Field Service

## • Outage Resource Planning Considerations

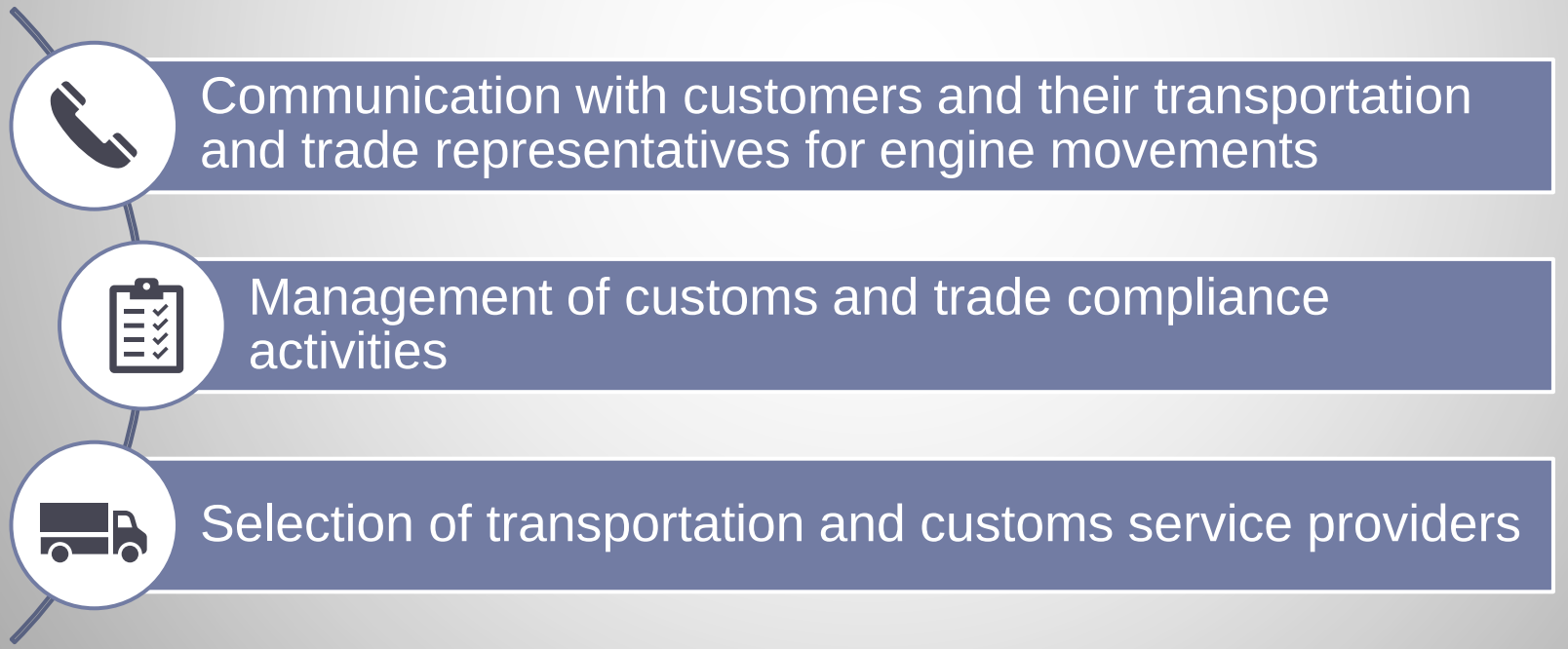
***Note: Outage Timelines listed below are averages only and vary by site specific conditions, work scope, Field Service crew size, customer supplied manpower, 12-hour shifts vs 24-hour coverage, weather, forest fires, and numerous other factors. Engage your provider for accurate timelines for your specific situation.***

- **GT Removal & Installation Timeline Averages**:
- GT Exchange: 3-5 Days
- GT Removal: 1-2 Days (remove GT, package berth remains empty)
- GT Installation & Commissioning: 2-3 Days
- **Contracted FS Crew size is dependent on availability and number of plant employees available to assist**

- **Additional Services that often accompany GT exchanges:**
- Emissions Mapping: 1-2 Days
- GT Control System Calibration: 1-2 Days
- GT Package Auxiliary Systems Inspection: 1-2 Days
- *Keep in mind some of these additional services can be worked simultaneously
- *Outage timeframes can be reduced significantly with 24-hour coverage but this may present a number of cost and safety related challenges. Recommend discussing these with your contracted Field Service Manager.

# Logistics

- The Logistics Team can manage the transportation/delivery of all engine parts, products, tooling, assemblies and/or modules inbound and outbound from the company/site/depot.
- Can be an internal or external resource and/or a combination of both.



# Transport Risks and Responsibilities

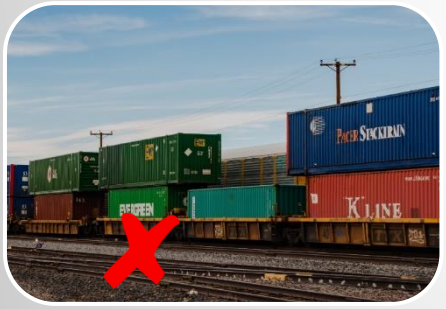
- Each engine typically has two Incoterms associated with it (inbound and outbound)
  - **Incoterms**: Internationally recognized rules that define the responsibility of sellers and buyers, identified by a 3-letter code
  - Ranges from:
    - EXW (seller's facility), lowest amount of responsibility for the seller/shipper
    - DDP (customer's facility), highest amount of responsibility for the seller/shipper

# Transportation Guidelines


Trucks and trailers with functioning air ride suspensions


Engines secured with chains

Cross-docking of engines is discouraged (TCT prohibited)




Rail transportation is prohibited


Engines should be tarped (TCT enforced)

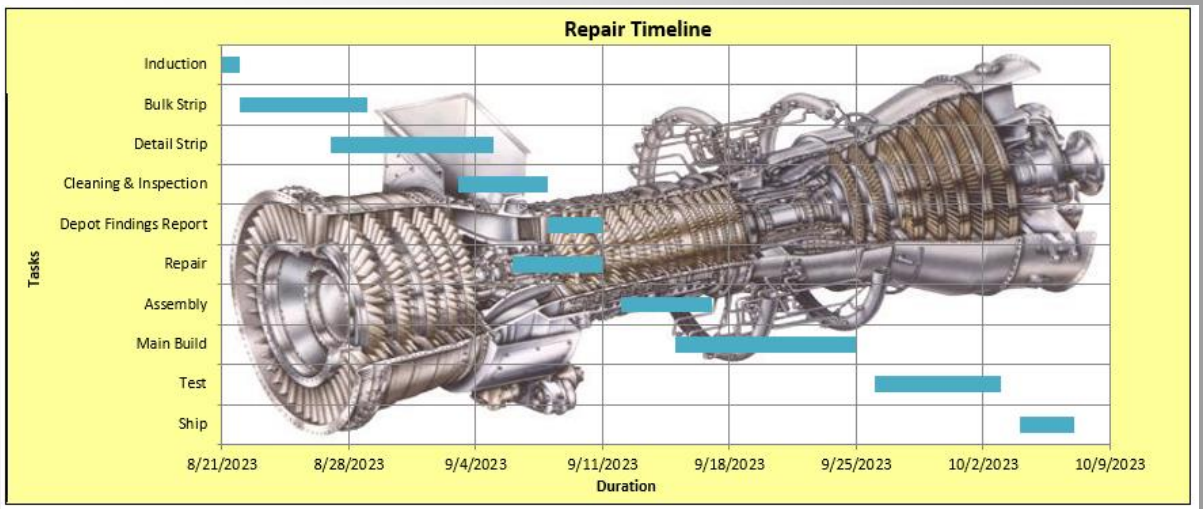

Compliant with local Health and Safety requirements

# Project Management

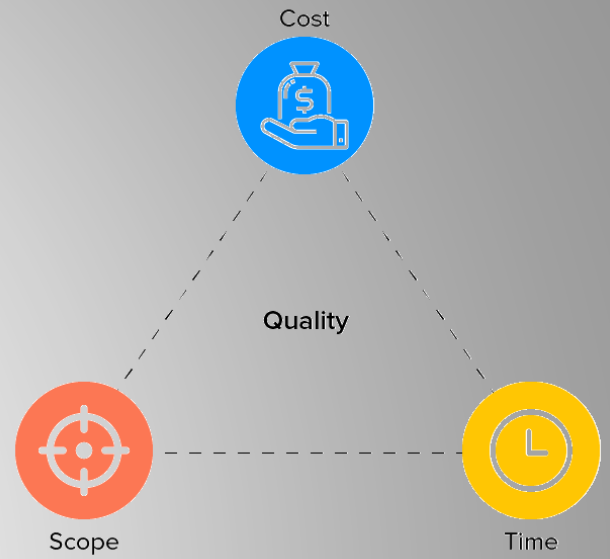
- The Project Manager (PM) serves as the primary liaison with the customer.

- The PM is responsible for the overall management of gas turbines through the repair process within the depot including:

  - Setting up the project
  - Identify the scope of work
  - Determine key parts utilization/resourcing
  - Managing the repair timeline
  - Cost estimating
  - Reporting on condition of the engine to the customer
  - Manage various stakeholders (customer, internal resources, contractors, vendors)
  - Ensuring all work is carried out in accordance with OEM manuals, specifications, & procedures in addition to customer requirements



# Project Management




- The PM establishes and manages customer expectations through the following:

    1. Scope – What is the desired end product?
    2. Time – How long will it take?
    3. Costs – How much will it cost?

*Communication is **key** to an effective Customer interface*

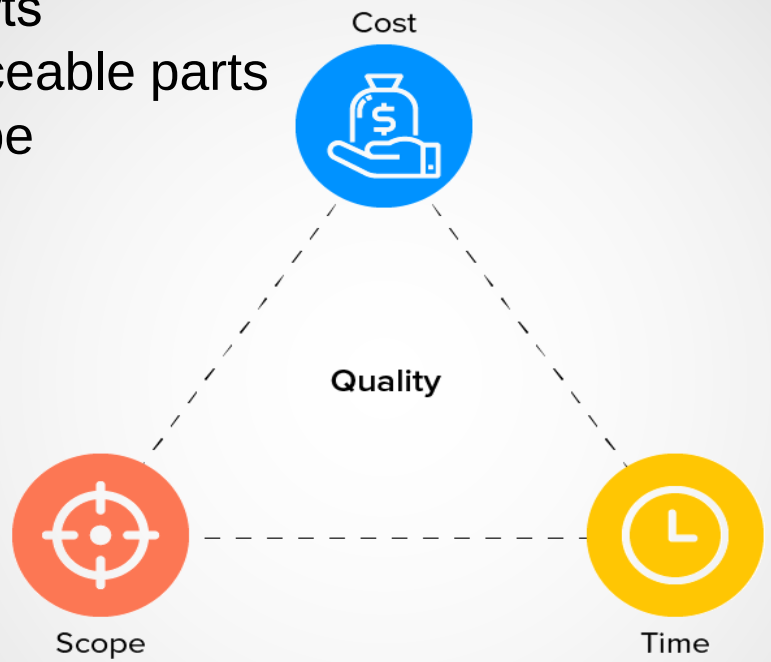
- Other aspects of the Customer interface may include:

    1. Reporting on incoming condition of the engine and subsequent detailed findings.
    2. Providing recommendations and options for various repair scopes.
    3. Progress updates throughout the project.
    4. Communicating project risks and presenting solutions.

# Project Management

If **COST** is priority:

- ✓ Repair engine's own parts
- ✓ Replacement with serviceable parts
- ✓ Add time or reduce scope




If **Scope** is priority:

- ✓ Limit or reduce optional scope
- ✓ Invest in pre-maintenance planning/scheduling
- ✓ Risk rank scope against budget & time
- ✓ Longer outage and/or higher budget

If **TIME** is priority:

- ✓ Use of Rotables / Pre-Built Modules
- ✓ Use of exchange engines
- ✓ Review budget
- ✓ Challenge scope

# Depot Production

- **Induction**
  - Engines received Tarped on an Air Ride truck
    - Tarped – to prevent exposure to environment elements
    - Air Ride trailer – prevent main line bearing damage (brinelling)
    - Engine is removed from shipping container and placed in Pedestals/Stands
  - As received inspection - Quality Inspector
    - All of engine areas photographed/documented
    - Engine condition and missing parts recorded
    - Shipping container inspected for serviceability


# Depot Production

- **Engine Teardown/Strip**

**Basic Disassembly**

- Specific Parts are removed for repair or replacement workscope dependent
- Majority of the engine is left assembled

**Module/Section Disassembly**

- Certain Sections/Modules of the engine are disassembled for repair or midlife
- The rest of the engine stays in one piece

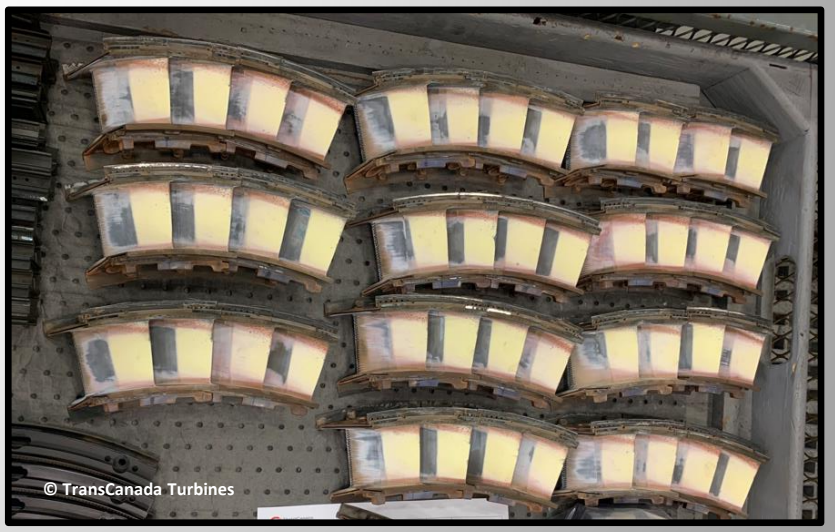
**Detail Strip**

- Engine is broken down into its most basic components – typically overhaul
- Every part is removed and taken apart

# Depot Production

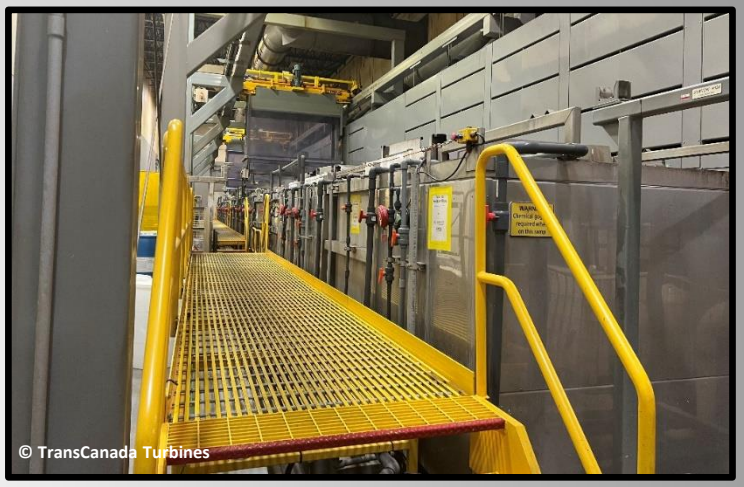
- **Repair Scopes**
  - Dependent on field findings.
  - Findings drive extent of dismantle.
  - Repairs performed as required based on needs of customer until next maintenance.
  - Can be planned or unplanned visits.


- **Overhaul Scopes**
  - Full dismantle to piece part level.
  - All parts inspected and refurbished (as required) to restore fit/form/function of the part until next major maintenance interval.
  - Typically planned visits.



# Depot Production

- **Cleaning**
  - Removes dirt, grease, oil and other contaminants from turbine components.
  - Used to remove specific coatings during overhaul.
  - Prepares the components for inspection, NDT, and reassembly.
  - Can improve the performance, efficiency, and reliability of the hardware.

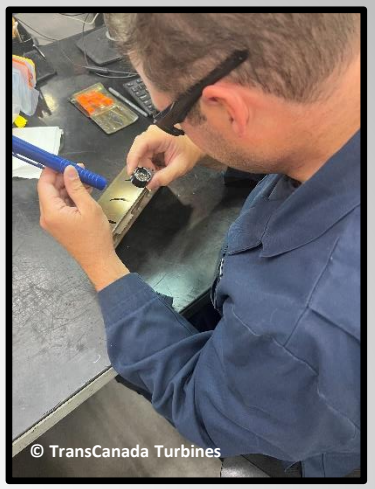



- **Common Cleaning Methods**
  - Vibratory Cleaning
  - Chemical Cleaning/Stripping
  - Abrasive Blasting (Dry and Wet)
  - Water Jet
  - Manual Hand Cleaning


# Depot Production

- **Inspection**

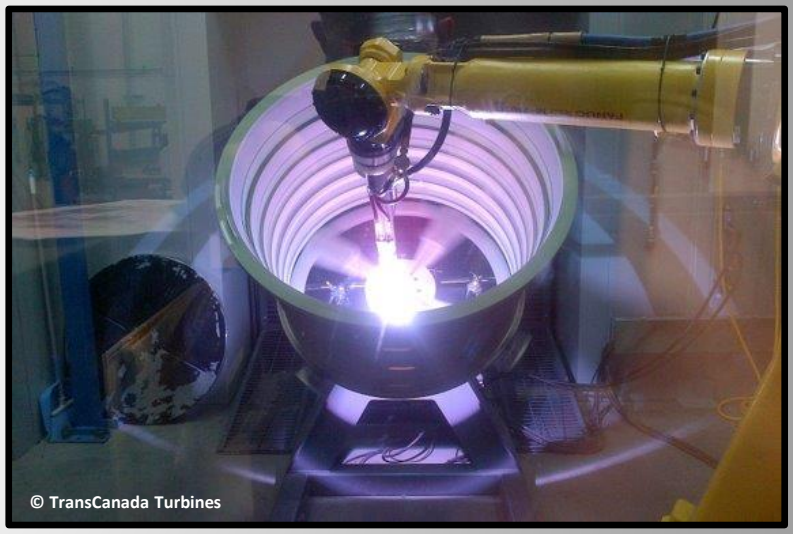
| Method | Description | Use |
|---|---|---|
| **Visual Inspection** | Direct observation according to OEM criteria | Surface defects including cracks, nicks/dents, material wear, corrosion, and other visible issues. |
| **Dimensional Inspection** | Manual or computer controlled measurements | Ensure proper clearances |
| **Liquid Penetrant Testing (PT)** | Uses a liquid penetrating dye on the surface of components | Small surface level cracks and porosity. |
| **Magnetic Particle Testing (MT)** | Uses magnetic fields and iron particles | Surface cracks and weld integrity |
| **Eddy Current Testing (ECT)** | Uses electromagnetic induction | Surface and subsurface defects in thin sections |
| **Ultrasonic Testing (UT)** | Utilizes high-frequency sound waves to detect internal defects, such as cracks and voids. | Accurate thickness measurement, internal flaws |
| **Radiographic Testing (RT)** | Involves X-rays or gamma rays to penetrate material | Internal defects, weld inspection |





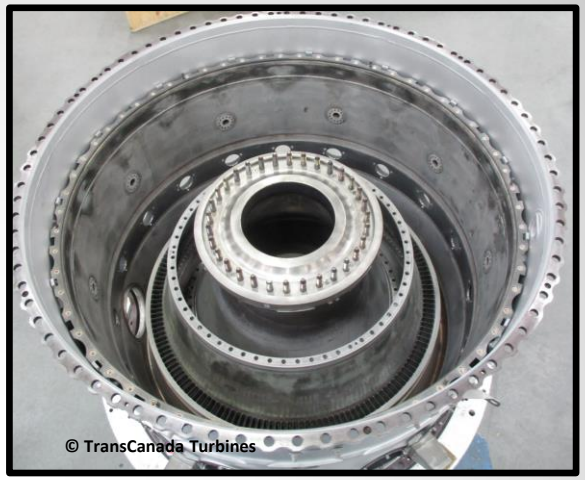
# Depot Production

- **Component Repair**
  - Based on inspection findings, parts may be routed internally or externally for repairs to re-establish fit/form/function of conditions found out of limits.
  - Capabilities like thermals spray, welding, brazing, plasma spray, CNC, and more are used to address the example conditions below:
    - Restoration/Application of various types of coatings
    - Restoration of abradable seals
    - Restoration of knife edge seals (rotating)
    - Dimensional Tolerance restoration of various features and/or surfaces
    - Non-Repairable parts are replaced with either New or Overhauled

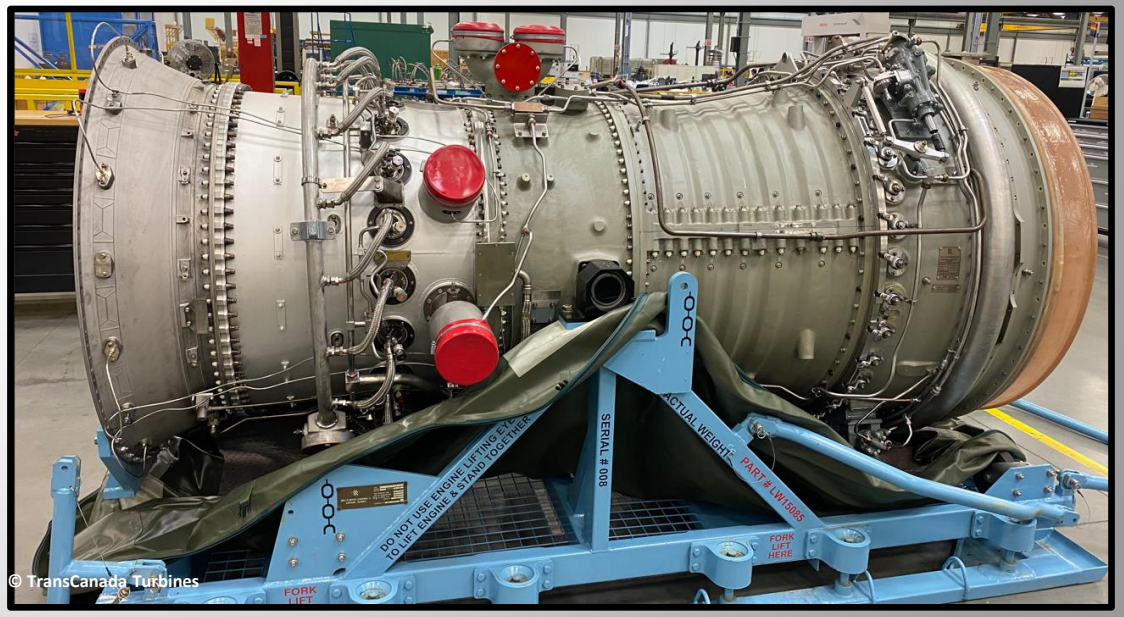


# Depot Production

- **Build**
  - Once all parts are available through the kitting process, the respective modules are released to production for build.
  - Technicians & Project Managers verify that the correct parts per configuration and Technical Bulletins are provided prior to installation.
  - Using the applicable OEM manuals, the modules are assembled and rotating modules are balanced as needed.
  - Completed modules are assembled to the engine.
  - Final build (Quality) inspection is performed.
  - Engine is sent to test if needed or prepped for shipment to site.







# Engine Testing

**Preparation**
- Pre test BSI
- Test Equipment installed
- Engine Rigged into thrust frame

**Test**
- Leak checks
- Variable geometry setup
- Break in process
- Performance test to OEM schedule

**Pass Off**
- Parameter checks to OEM criteria
- Performance Analysis using OEM software

**Quality Assurance**
- Full post test BSI
- Engine inspections
- Preparation for shipment



# Engineering

Provide Technical/Engineering support to the business.

Production Support –
Build Defects/snags
Inspection dispositions

Customer support –
Technical information
Troubleshooting site issues
Site/package surveys.
Dedicated Field Service Engineering resources

Component Repair Support
In-House & Vendor Technical support
Repair Development
Optimize repair vs replacement strategy

Projects Support -
Assist with non-routine workscope development.
Service Bulletins, OIA's, Modifications and upgrades

Inspection Support –
Technical interpretations, facilitate OEM condition acceptance requests.

Event investigations
Failure analysis (fractography, metallography)
Root cause
Corrective/preventive actions

Engine Test Troubleshooting and performance optimization.

Engineering solutions- QIC's, SOC's, process improvements, tooling redesigns etc.

# Thank You.
# Questions?