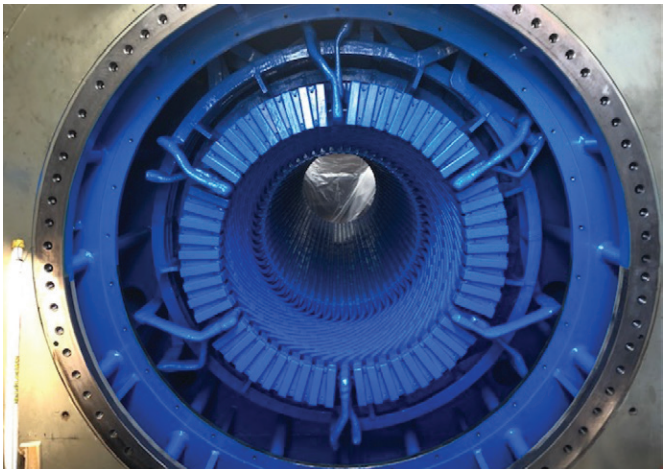
7FH2 OVERVIEW

TG Advisers are turbine and generator experts who provide engineering services to the power industry. Our mission is to be recognized as a valued leader of independent equipment assessments, expert 3rd party design reviews, and O&M optimization solutions and services. Our TGA Generator Engineering team has over 50 years combined knowledge with respect to generator evaluation, testing, recommendations, and overall technical expertise.



7FH2 DESIGN EOL APPROACHING

During the gas boom of the 1990 and early 2000s, over 950 7FH2 model generators were manufactured. Some of these were manufactured by the OEM while others were manufactured utilizing global licensees. As the 30-year service end of life (EOL) is approaching for a large number of these units, older units are subject to time dependent and/or chronic problems such as insulation degradation, increased vibration on load, thermal instability, and unintended relative movement that eventually require repair, replacement, or full stator/field rewinds. While addressing these issues too early can be cost prohibitive, delay can lead to large, unexpected capital expenditures either during routine outages or unexpected forced outages. If a stator or field has already been rewound, continued effective maintenance programs can be implemented and utilized to extend unit life longevity.

Within TGA Generator Engineering, our team has expertise veterans who can help assist maintenance and operations staff with technical advisement many users will need as these units approach their designed EOL. Our TGA database includes data on nearly 120 Gigawatts of power generational capacity. We offer OEM-level insight in an unbiased manner to benefit you.

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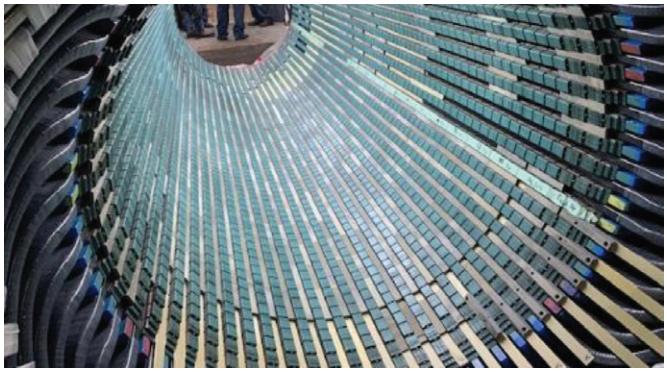
COMMON 7FH2 FLEET ISSUES

DRY-TIE DUSTING

Early 7FH2 manufactured stator iterations utilized a “dry tie” technique to secure circuit rings and blocking to axial supports. These dry ties have since been proven to be unsatisfactory and have led to unintended circuit ring insulation abrasion during operation. This abrasion can degrade circuit ring insulation, ties, and present the opportunity to fail in-service if not addressed in a timely manner.

KEYBAR RATTLE / IMPROPERLY TORQUED

Stator core iron is axially compressed by keybars which provide a stable slot profile which extends stator winding life expectancy. Thermal expansion and contraction due to cyclic loading can prematurely degrade keybar compressive forces during operation. Improperly torqued cores can lead to fretting/delamination of stator core iron, significant back of core iron burning, and ferrous material introduction to the stator and/or field if core iron burning is significant enough.fail in-service if not addressed in a timely manner.

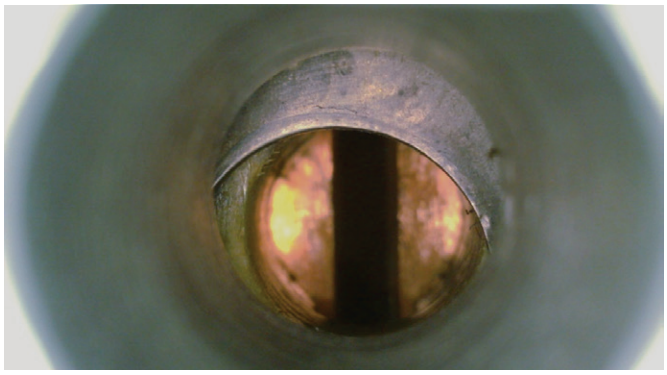


DEFICIENT WEDGE SYSTEM

Thermal expansion and contraction can degrade wedge integrity during operation, particularly during cyclic operation. Stator slot wedges provide radial ompression/retention to stator bars throughout the axial portion of the stator core slot. A deficient wedge system can lead to loss of semiconductive coating, bar insulation degradation, spark erosion, and foreign debris intrusion into the unit during operation if a loose end wedge were to liberate.

BELLY BAND LOOSENESS

Compression radial bands (belly bands) have been installed on many 7FH2 generator stators to help mitigate vibrational levels of the unit. In a typical 7FH2 configuration, the band tension devices are located below the generator stator and are accessed via hydrogen cooler removal. Radial bands must be inspected to ensure operation has not degraded mechanical components and tell-tale signs of looseness (greasing) are not noted.

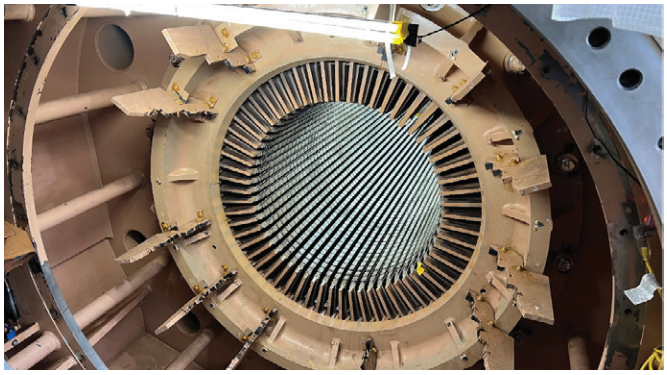


FIELD SPRING MIGRATION

Springs that run the axial length of the field forging are utilized to provide adequate radial compressive forces. 7FH2 model generator fields have been shown to exhibit spring migration, which can lead to blocked ventilation passes. Blocked ventilation passages can lead to significant thermal heating, which can lead to compromised coil/turn insulation and vibrational instability.

COLLECTOR STUD H2 LEAKING

Today's 7FH2 model generator fields have a Chevron seal gasket within the collector stud terminals. This seal is intended to prevent the back flow of hydrogen gas from the unit and out through the collector terminal studs. Routine Static Excitation DC collector ring sparking, coupled with a collector stud leaking hydrogen gas may create a potentially catastrophic explosion hazard. Collector stud seals should be pressure tested to ensure Chevron seal gasket integrity.

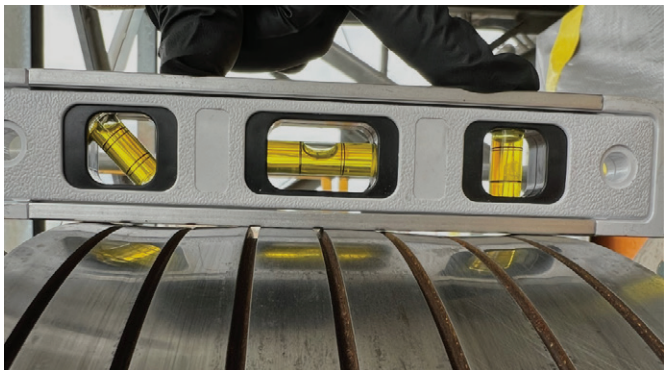


LOOSE AXIAL SUPPORT HARDWARE

Axial supports provide a base for binding bands to securely attach which will in turn provide a solid base for bottom bar installation. Loose hardware, improperly torqued nuts/locking nuts have been noted on a significant portion of 7FH2 fleet wide generators. Loose hardware can become dislodged during operation and can be introduced into the generator. Loose hardware can damage all components of both the stator and field if caught within the cooling circuit leading to field forging damage, core iron damage, broken/compromised ties, or stator bar short circuits if lodged.

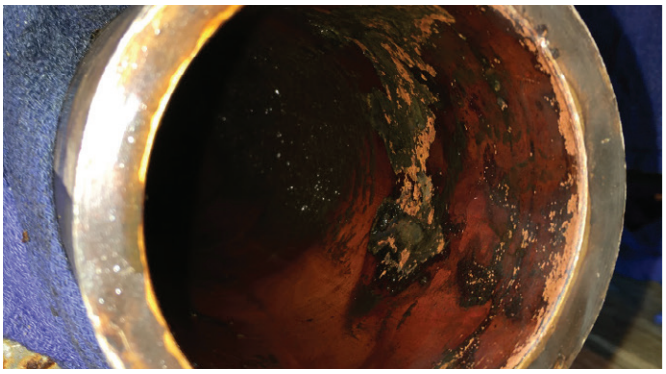
MEDIUM AND HIGH VOLTAGE EQUIPMENT ENCLOSURE

Most 7FH2 generator units are located outdoors with weather-resistant terminal enclosures housing generator winding terminals, isophase bus work, and current transformers (CTs). Unintended or accidental water, dirt, and general contamination ingress into these compartments can result in significant electrical equipment damage. Water ingress can short circuit line side terminals during operation. Animal ingress and/or nesting has also been observed during routine inspections very near to the terminals.



COLLECTOR RING DISHING

During operation carbon brushes provide static excitation to field collector rings. If improperly maintained, carbon brushes can contribute to uneven wear of collector rings leading to premature degradation of the collector rings. Inspection of collector rings during routing maintenance outages should be used to assess the condition of both inboard and outboard collector rings. Machining and/or re-surfacing may be necessary to continue to provide adequate excitation via carbon brushes.



HIGH VOLTAGE BUSHING (HVB) OIL INGRESS

In some vintage 7FH2 configurations, HVBs are located below the generator stator within the hydrogen cooling gas bushing box. If hydrogen seal leaks are present, oil ingress into the generator stator is experienced. If enough oil is introduced into the stator, HVBs can be affected by this oil, leading to overheating of internal HVB components outside of design parameters.

TG ADVISERS CAPABILITIES

TROUBLE SHOOTING

TG Advisers has the expertise to troubleshoot a wide variety of generator operating issues including vibration, on-line analysis testing, performance shortfalls, and chronic mechanical or electrical issues.

ROOT CAUSE FAILURE ANALYSIS

TG Advisers is versed in several formal failure analysis techniques. Depending on the particular need, we can participate, facilitate, or lead a formal failure analysis process. In addition, our network offers a full range of material testing, examination services, and Finite Element Analysis.

STEAM & GAS TURBINE GENERATOR HEALTH ASSESSMENTS

Recent inspection reports alone will not allow for the most effective planning because many failure modes are time dependent and/or chronic in nature. Through our Turbine Generator Health Assessment Process, we conduct interviews with operations personnel, review all available inspection reports dating as far back as unit commissioning and, using detailed knowledge of the design basis, materials, and critical service issues, develop a risk weighted action plan for the next outage.

TG Advisers has completed more than 300 plant assessments resulting in O&M savings of more than $150,000 on average per unit.

CAPITAL & MAINTENANCE OPTIMIZATION

Repair, replace, or upgrade? TG Advisers can help. We have the technical and financial background to evaluate complex trade-offs and evaluate vendor proposals regardless of whether it is a viable repair recommendation, field swap program, or full stator/field rewind.

OUTAGE CYCLE OPTIMIZATION

TG Advisers shows customers how they can save millions by transitioning from a fixed schedule of major outages to a customized schedule of smaller component focused outages which results in a more appropriate inspection regime with significant cost savings.

STEAM & GAS TURBINE GENERATOR DESIGN REVIEWS

A structured technical review with an experienced and unbiased third party is an excellent method to mitigate such risks. If conducted early in the planning process, such an evaluation can be used to identify areas that should be addressed through contractual requirements. Weak points where independent assessment should be conducted can be incorporated into the project schedule. TG Advisers Generator Engineering has more than 50 combined years of generator technical and repair experience on fossil and nuclear applications. The TG Advisers Generator Engineering team offers a proven design review process to identify design weaknesses up front and address concerns before major commitments are made.

SHOP / ON-SITE SURVEILLANCE SERVICES

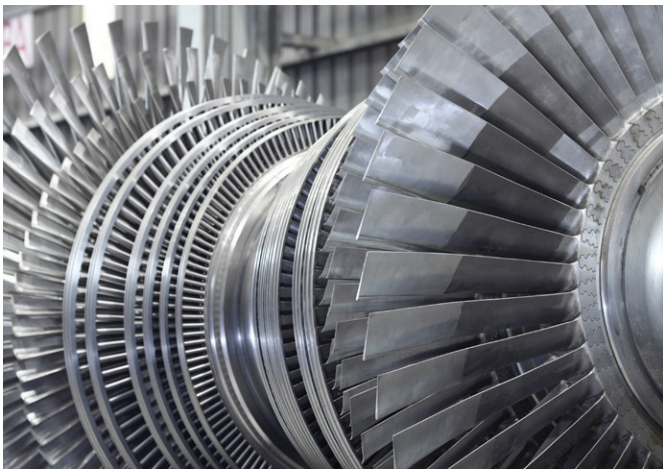
Have components in the shop for manufacture or repair? Your job will likely be one of many in progress at the facility. Have OEM or independent repair engineers/technicians working at your facility stretching the oversight availability of your in-house staff?. TG Advisers can provide independent shop repair surveillance services to ensure critical repairs or new unit work is completed to specification and to the correct industry standards and practice.

ASK AN EXPERT SUPPORT

Have a question and want an independent or second opinion? TG Advisers provides on-line, phone or site support for a fixed hourly rate, or retainer, at a substantial discount to published OEM rates. In addition, customers who purchase a Health Assessment are eligible for a discount. Need to go out for bid for a complex repair or replacement part? Received a number of bids and want an independent review? TG Advisers can prepare the technical portion of bid specifications with the knowledge of what's important. We know how to evaluate vendor submittals and what to look for in their technical and price proposals.

EXPERT WITNESS TESTIMONY

TG Advisers can provide independent pre-trial technical analysis and review relevant generator specific issues. Our experts can support litigation reviews and provide expert witness testimony at trial. Our years of first-hand knowledge and experience are invaluable in understanding and evaluating critical operations of systems worldwide.



OEM SERVICE REVIEW / BULLETIN AUDIT

Too many TILs to keep track of? TG Advisers can conduct an internal audit of pertinent OEM service bulletins and devise an effective testing and maintenance program based on these bulletins. Many of the service bulletins contain information needed for effectively and safely continuing operation of specific units.

PLANT DUE DILIGENCE ASSESSMENTS

Many of our clients are actively purchasing and selling units around the world. Together with our assessment process, we can provide a comprehensive review of a unit, including its environmental condition, operating structure, and maintainability, thereby supporting any buy or sell evaluation for your firm's consideration. Sometimes fatal unit flaws in a power plant's operations are not recognized by teams who do not have the advantage of possessing the technical depth of our TG Advisers team. We have combustion, balance of plant, environmental, and turbine generator experts who can quickly assess a unit and provide realistic operational, maintenance and capital outlay projects for the long term.