GEK 103589
September 1994
Last Reviewed, October 2003

GE Power Systems

Allowable Exhaust Pressure Operation

Variable Limits

These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes the matter should be referred to the GE Company.

I. INTRODUCTION

Turbine Exhaust pressure limitations are necessary to minimize the possibility of latter stage bucket fatigue damage and bucket or exhaust hood damage due to overheating.

Extensive field testing has been conducted to measure bucket response on various bucket designs throughout the load range and for various exhaust pressure conditions. These tests have shown that, particularly at light load, sustained operation at higher than recommended exhaust pressure can result in bucket response that increases the probability of high-cycle fatigue cracking or failure. This is due to buffeting of the bucket vanes caused by steam flow at extreme off-optimum entrance angle conditions.

The bucket response levels for a given set of conditions will vary depending on bucket row construction (coupling, damping, etc.) and the bucket vane shape (stiffness).

Overheating can occur due to windage, which increases as exhaust pressure increases. This can cause bucket structural problems in the extreme case (e.g., stretching) as well as exhaust hood distortion. While exhaust hood water sprays, if properly installed and operating, will cool the hood, and to some extent, the last stage buckets, L-1 stage overheating can still occur.

II. EXHAUST PRESSURE LIMITS

The turbine-generator has been designed with an exhaust pressure alarm function that alarms at an exhaust pressure condition that is not acceptable for continuous operation, and a trip function that protects the equipment in the event that certain alarm conditions are not cleared quickly, or in the event that the alarm condition reaches a certain magnitude. Due to their rugged continuously coupled construction, the buckets identified by this GEK can withstand higher exhaust pressures than other GE designs. Limits are set as a function of flow through the last stage buckets to allow flexibility of operation while maintaining structural integrity. The flow is measured by assessing the V_{an}, or average axial annulus velocity exiting the last stage of the turbine. Back pressure limits with respect to V_{an} are shown in Figure 1. As a guide for operation, V_{an} is calculated by the control system and is displayed in the control room. The alarm and trip signals originate in vacuum measuring devices. Thus the power plant altitude has been factored into the actual exhaust pressure settings. Deviations from the “normal” atmospheric pressure for the plant elevation may be taken into account in interpreting alarm signals.

The condensing system may be designed such that certain short duration transient operations (such as a trip or load rejection) that could incur exhaust pressure excursions above the alarm set point are permitted. The time spent above alarm during this condition must be minimized (less than 3 minutes per event) and should remain below the trip setting. Generally, the heat transfer characteristics of the condenser are such that, at reduced speed, the turbine vacuum will be better than at full load. The condenser should be capable of absorbing the large heat loads associated with startups, load rejections, and trips without exceeding the alarm setting. However, there are operating conditions such as condenser backflushing, operating with a large capacity turbine bypass, condenser fouling, vacuum leaks, etc. that could result in exhaust pressure higher than alarm.

A trip setting higher than the alarm setting is used because the preferred method of correcting a high exhaust pressure condition at higher loads is load reduction rather than trip, which would result in a turbine overspeed transient.

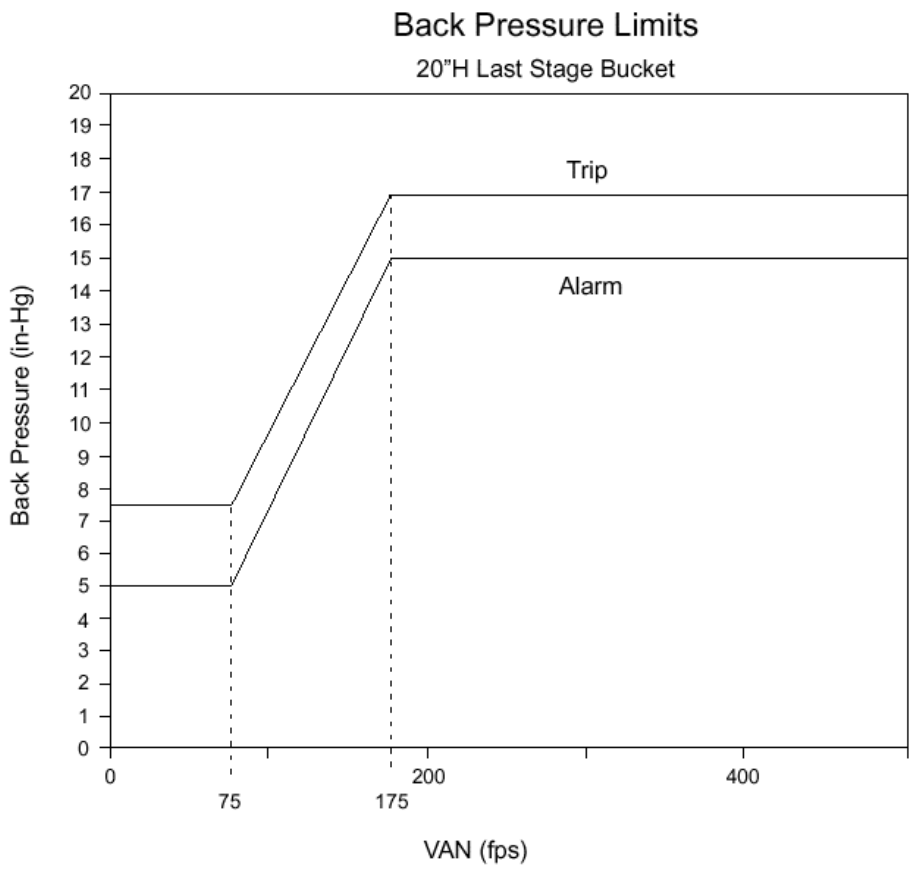

Figure 1.

III. RECOMMENDED PROCEDURES

The turbine should not be operated continuously with exhaust pressure above the alarm setting.

Operation at low load should be performed at the best attainable exhaust pressure.

If the exhaust pressure exceeds the alarm setting, load should be reduced until the proper pressure is restored. If load reduction to 30% of rated output does not reduce the exhaust pressure below the alarm setting the unit should be tripped, making sure all turbine valves close and negative generator power is obtained before the main circuit breaker is opened, to avoid a serious overspeed incident.

Vacuum should not be broken after trips until unit speed reaches $^{2}/_{3}$ rated speed, i.e., 2,400 rpm [40 rps] for a 3,600 rpm [60 rps] unit, 2,000 rpm [33.3 rps] for a 3,000 rpm [50 rps] unit, 1,200 rpm [20 rps] for an 1,800 rpm [30 rps] unit, 1,000 rpm [16.7 rps] for a 1,500 rpm [25 rps] unit. To prevent cross-flows on multihood units, vacuum should be broken simultaneously in all hoods. If an emergency condition arises that requires the turbine to be brought to rest as quickly as possible, it may be necessary to break vacuum immediately on tripout to minimize overall damage to the unit.

IV. EXHAUST PRESSURE MEASUREMENT

The exhaust pressure should be measured at a point representative of the last-stage exhaust conditions. The most representative case is to measure the pressure in the turbine exhaust hood. Pressures measured in the condenser or at the hotwell should not be used to guide turbine operation.

In the case of multihood units with separate condensers, different exhaust pressures can be experienced, e.g., due to series operation or backflushing. In these cases, it is recommended that the pressure be monitored in each hood.

The maximum differential pressure between adjacent hoods of a multihood unit should not exceed 2.0 in Hg [6.77 kPa] [0.069 kg/cm^2].

GE Power Systems

General Electric Company
One River Road, Schenectady, NY 12345
518 • 385 • 2211 TX: 145354