CVEN 458 – Hydraulic Engineering of WDS
Spring Semester 2015
Dr. Kelly Brumbelow, Texas A&M University

Exam #2

Open-book, Open-notes (2 problems); Time allowed: 60 minutes
All work must be written on separate pages with your name written on each page.

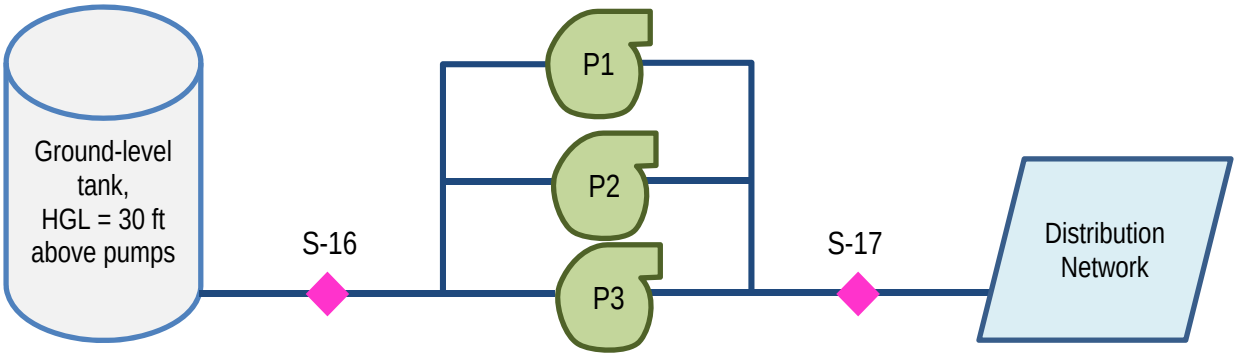
1. A municipal water utility retains your firm's services in response to a recent "incident" at one of its high-service pump stations. This pump station has 3 pumps installed in parallel, all of which are Aurora model 3550 sized 6x8-15 with 12.25 inch impellors (technical data from manufacturer is attached). Two of the pumps are constant-speed pumps that always operate at 1780 rpm (designated "P1" and "P2"); the third pump has a variable-speed drive capable of operation at speeds between 600 and 1780 rpm (designated "P3").

You have interviewed the operator on duty at the time of the incident and he stated: "It was early in the morning, and I knew that our morning demand peak was not too far away. We had 2 pumps operating, so I switched on the third pump so we'd have plenty of flow and pressure. Within about 30 seconds there was all this noise coming from the pump gallery, and I got really nervous and shut everything down."

Drawn below is a schematic of the pump station. Also given below is a data table pulled from the utility's SCADA system around the time of the incident. A sheet of graph paper is also attached for your convenience.

Given this information, what is a plausible explanation for what occurred during this incident?
(75 points)

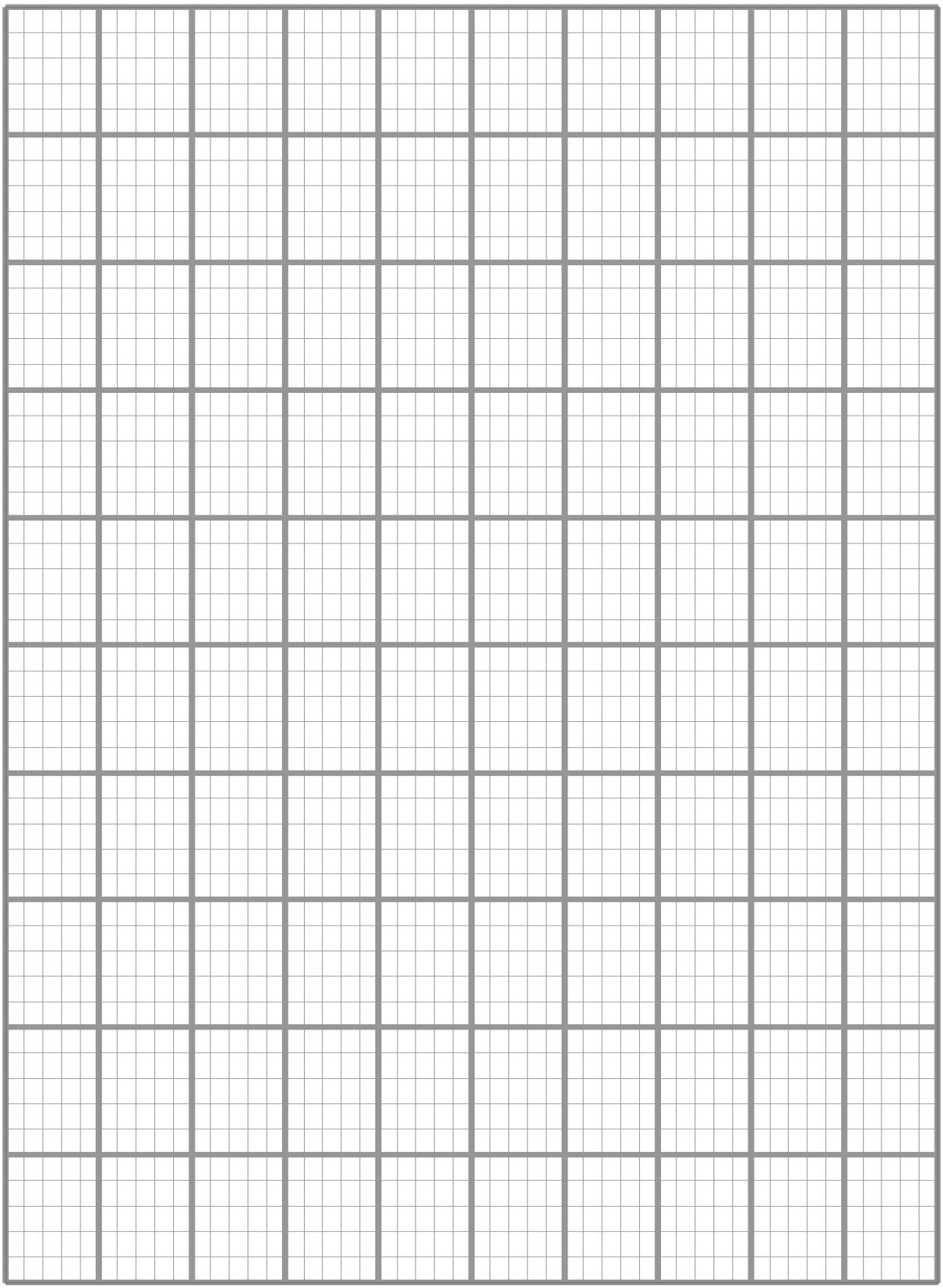
Pump station schematic (including SCADA sensor locations shown as pink diamonds):



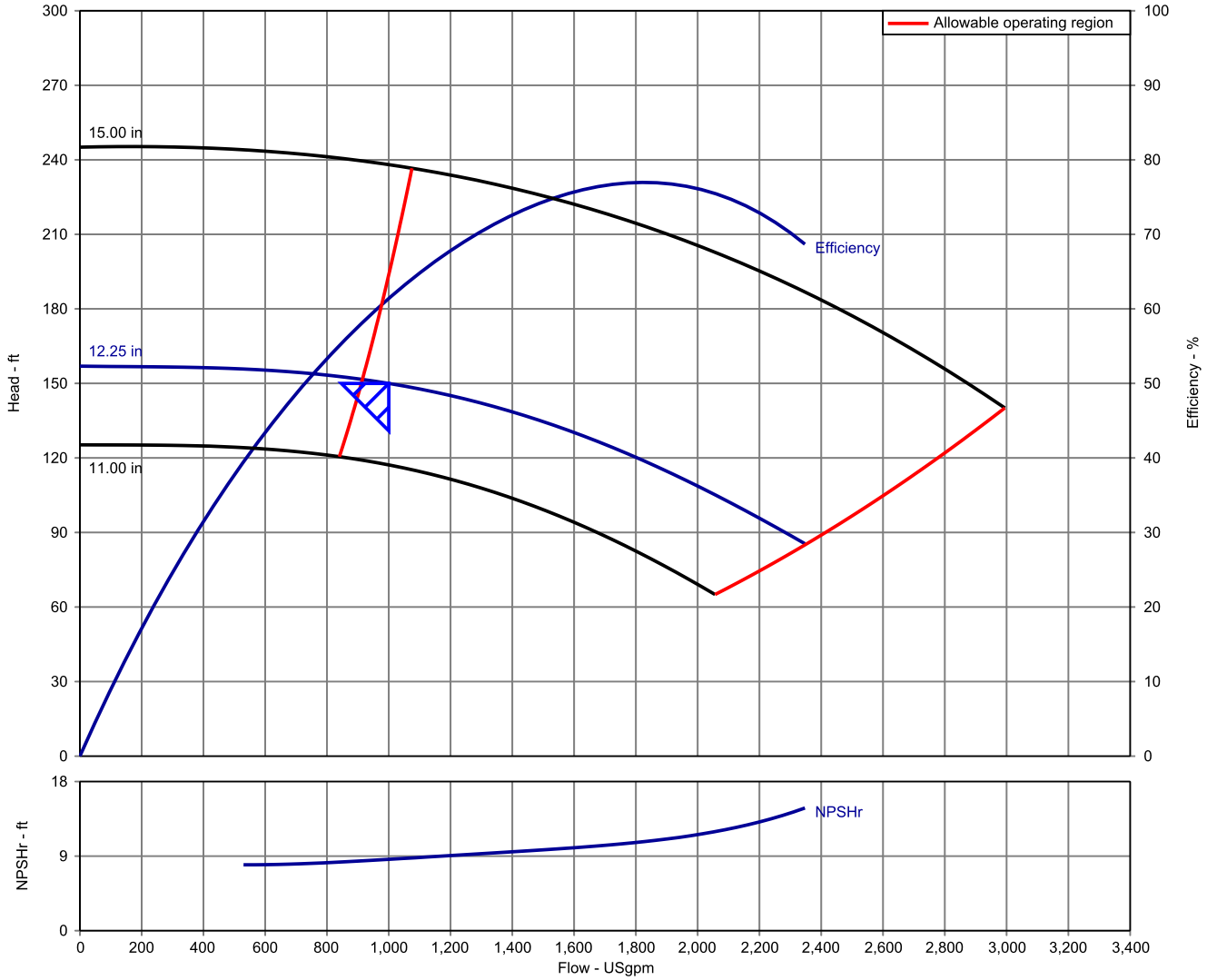
SCADA data for period – Pump P2 started at 4:07:26; All pumps switched off at 4:08:16.

Time	S-16 Flow (gpm)	S-16 Pressure (psi)	S-17 Flow (gpm)	S-17 Pressure (psi)	P1 Status/ Speed (rpm)	P2 Status/ Speed (rpm)	P3 Status/ Speed (rpm)
4:07:00	3007	13.1	3009	59.9	ON/1780	OFF	ON/1575
4:07:10	3010	13.2	3006	59.9	ON/1780	OFF	ON/1575
4:07:20	3008	12.9	3011	59.8	ON/1780	OFF	ON/1575
4:07:30	3000	12.9	3004	61.2	ON/1780	ON/100	ON/1575
4:07:40	3012	12.6	3015	65.2	ON/1780	ON/1240	ON/1575
4:07:50	3015	12.5	3011	69.4	ON/1780	ON/1780	ON/1575
4:08:00	3010	12.5	3009	69.3	ON/1780	ON/1780	ON/1575
4:08:10	3005	12.8	3008	69.3	ON/1780	ON/1780	ON/1575
4:08:20	2520	13.3	2529	68.1	OFF	OFF	OFF
4:08:30	1110	13.4	1118	68.1	OFF	OFF	OFF

2. You are developing an EPANet model for a building fire-protection system that will include ceiling mounted fire sprinklers. Each sprinkler will discharge water through a circular orifice 0.14 inches in diameter. The sprinklers are fabricated so that the discharge orifices have sharp edges. What are appropriate values for the EPANet emitter discharge exponent and coefficient for the sprinklers? *(25 points)*



Pump Performance Curve



Customer	:	Size	: 3550-6x8-15
Customer reference	:	Stages	: 1
Item number	:	Speed, rated	: 1,780 rpm
Service	:	Based on curve number	: 553-6x8x15-1780
Quantity	: 1	Efficiency	: [redacted]
Quote number	:	Power, rated	:
Date last saved	: 24 Apr 2012 4:10 PM	NPSH required	:
Flow, rated	: [redacted]	Viscosity	: 1.00 cP
Differential head / pressure, rated	:	Cq/Ch/Ce [ANSI/HI 9.6.7-2004]	: 1.00 / 1.00 / 1.00
Fluid density, rated / max	: 0.999 / 0.999 SG		